Identifying Learning Strategies Associated with Active use of Video Annotation Software

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ABSTRACT

The higher education sector has seen a shift in teaching approaches over the past decade with an increase in the use of video for delivering lecture content as part of a flipped classroom or blended learning model. Advances in video technologies have provided opportunities for students to now annotate videos as a strategy to support their achievement of the intended learning outcomes. However, there are few studies exploring the relationship between video annotations, student approaches to learning, and academic performance. This study seeks to narrow this gap by investigating the impact of students' use of video annotation software coupled with their approaches to learning and academic performance in the context of a flipped learning environment. Preliminary findings reveal a significant positive relationship between annotating videos and exam results. However, negative effects of surface approaches to learning, cognitive strategy use and test anxiety on midterm grades were also noted. This indicates a need to better promote and scaffold higher order cognitive strategies and deeper learning with the use of video annotation software.

Categories and Subject Descriptors

J.1 [Administrative Data Processing]:Education; K.3.1 [Computer Uses in Education] Computer-assisted instruction (CAI)

General Terms

Algorithms, measurements, human factors.

Keywords

Video annotation software, learning analytics, learning strategies.

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1. INTRODUCTION

There is a long history of research in educational technology that has aimed at identifying whether the introduction of a particular technology has (or has not) improved student academic performance. In the words of John Hattie it would appear for education that "everything seems to work" [14]. That is, the introduction of technology or for that matter any education-based intervention generally improves student test scores. It is easy to understand why research on educational technology and, more recently learning analytics, has focused on assessment scores as an outcome in lieu of, for example, the more complex approach of determining change in student learning strategies [17]. Data on assessment is readily accessible, easy to measure and amenable to longitudinal studies. In contrast measuring learning processes such as, self-regulated learning (SRL) is more complex with measures commonly reliant on self-reports. However, more recently the work of Winne [26], Azevedo [1] and others have demonstrated the potential to establish indicators of SRL proficiency through the analysis of student interactions with a technology. That is, the analysis of trace data to provide insight into the measurement of student judgment of learning and meta-cognitive monitoring. In this paper we describe a case study to examine students' strategic use of a video annotation tool as a means to support their learning process.

The rest of the document is organized as follows. Section 2 presents the work in the area of video annotation in the context of active learning scenarios. Section 3 describes the methodology used for the case study. Section 4 presents the results obtained in the study. The conclusion and lines for future work are described in Section 5.

2. RELATED WORK

The use of pre-recorded lecture videos as a teaching strategy is gaining increasing momentum across the education sector. This is in part due to advances in video recording technology, increased adoption and growing enthusiasm for the "flipped classroom" teaching model. While the concept is only recently receiving much recognition it is not a novel teaching strategy. The concept commenced in the early 2000s when it was recognized as a means for catering to different learning styles [18]. Since then, it has been adopted in a variety of disciplines in order to make the best use of the minimal amount of face-to-face time to enable more collaborative activities and active learning that provide greater opportunities for student and teacher interaction [15]. For example, a recent study in a first year pharmaceutical course has shown that the flipped classroom approach led to increased attendance and improved exam performance as students independently explored course material but applied their understanding to active learning activities in class [19]. Similarly, a study investigating third year engineering students' perceptions of a flipped classroom approach revealed that most students found the online video lectures more convenient as this provided just in time access to course content and students could rewind video material to review difficult concepts as required [9].

An outcome of the increased adoption of "blended" or flipped classroom models has been the greater use and integration of video content. While traditionally, video has been a passive and one way activity more recent advances in video technologies have included time-stamped annotation features whereby students can make comments and reflections for themselves as well as sharing with peers and instructors [6, 23]. Studies investigating the perceptions of pre-service teachers [5] and medical students [16] annotating videos of their own teaching or simulated patient consultation reveal that student's perceive that video annotations enhance their learning experience, critical reflection and provide easy identification of areas for improvement.

While these studies report the benefits of the flipped classroom or video annotation approaches, they have relied heavily on students' self-reports to determine the extent that students accessed the video materials. This self-report approach can lead to inaccurate data due to social desirability bias [2, 11] or incorrect recall of prior behavior. In contrast, learning analytics and data-mining approaches interrogate the trace data from students' actual use of the lecture videos and, hence, can provide more objective data for analysis [12]. Recent studies have used learning analytics and data-mining to investigate students' actual engagement with lecture videos by clustering students based on video tool access [4] and how such objective data when coupled with results on related quizzes [20] can inform instructors' pedagogical approaches and intervention strategies. Similarly, related studies into students' annotations have used logged data to investigate the length of time-stamped annotations compared to hand-written notes [21] and patterns in the linguistic and cognitive processes inherent in the text of the annotations [10].

Although there are numerous studies reporting associations between grades and variables obtained from data traces (for example [24]), there is a lack of analysis to expand these associations in order to unpack students' approaches to learning to understand the underlying associations. This lack of insight could significantly impede the effectiveness of any instructive feedback and recommendations that are ultimately provided to the student. This is especially true when the use of technology is considered part of the self-regulated learning process [25]. In such a process, students are perceived to be active agents in their learning choices and therefore make decisions about the tools they are going to use for their learning. According to Winne [25], those decisions are made based on external and internal conditions. External conditions would include, for example, the graded use of a tool in a course of study. While internal conditions would involve metacognitive knowledge, motivation, and prior knowledge. Specifically, the present study looks at the effect of internal conditions (approaches to and motivational strategies for learning) on the association between tool use and academic performance. The study is conducted in the context of a flipped classroom that embedded the use of video annotation software as part of the instructional design.

3. METHOD

3.1 Study Design

The following case study collected data from a first year course at a higher education institution deployed following a flipped learning strategy. The data was collected from student use of a video annotation tool, called the Collaborative Lecture Annotation System (CLAS - a web-based video annotation application) [7, 23]. The study was carried out in the context of a natural experiment as student participation was voluntary and beyond the control of the researchers.

3.2 Materials

The study used three data sources. The first was data extracted from CLAS. This tool offers two types of annotations. The first form of annotation allows the insertion of a general comment about the video. The second is a time-stamped annotation, whereby a comment is made directly related to a specific point in the video time-line. Both types of annotations can be made private or public to a set number of users that have been previously given access to a collection of videos associated with a course. For the purposes of this study, data about the date, time and number of annotations per student were analyzed. The number of annotations is considered an estimation of the level of engagement of students with the task as a more explicit engagement with the resource than simply pressing the video play button.. This measure is applied in lieu of the time the video is viewed, as that measure is subject to inaccuracies that requires special heuristics [13].

The second data source related to the administration of the Motivational and Self-Regulated Learning Questionnaire (MSLQ) [22] and the Study Process Questionnaire (SPQ) [3] at the commencement of the course. The questionnaire contained 64 questions presented as a seven level Likert scale. Lastly, the third data source included the scores the students obtained on a midterm examination consisting of 20 multiple choice questions.

3.3 Sample

The data was collected in the 2014 offering of a first year course (n=300) at a large metropolitan University. Given the voluntary nature of the study a total of 149 students participated comprising, 38 females and 111 males. The course followed a flipped classroom pedagogical strategy whereby students completed a set of tasks to prepare for the weekly face-to-face lectures. One of these tasks required the use of CLAS. Students were invited to write a general summary of the pre-recorded video. In addition, students were requested to identify and provide three time-stamped annotations about the concepts presented in the video at the specific time they were explained. The participation in these tasks was optional and indirectly assessed through a collection of problems with multiple-choice questions that must be submitted before each face-to-face session. The videos provided in CLAS aimed to assist student understanding of the concepts required to solve the collection of problems. All the operations related to the videos were stored in the logs produced by CLAS and used for the study.

The case study reported in this paper focuses first on verifying that a higher engagement with the video annotation tool correlates with a higher academic achievement. We then explore which aspects of learning explain a higher variation of the score in the midterm exam together with the use of CLAS.

3.4 Variables and Measures

Independent Variables. The main independent variable used in the study to test the effect of the use of CLAS is based on the number of annotations (both general and time-stamped) submitted by each student. The variable was re-encoded as a binary variable with the value zero if a student did not submit any annotation and one if an annotation was made. Furthermore, we used nine additional covariates derived from the MSLQ and SPQ questionnaires as independent variables. In the MSLQ, questions are grouped into five scales: Intrinsic value (IVAL), Self-Efficacy (SEFF), Test Anxiety (TANX), Cognitive Strategy Use (CSUS) and Self-Regulation (SREL). The value of each covariate is computed as the average of the answers to the questions in the group. Analogously, SPQ groups the questions into four scales: deep motive (DM), deep strategy (DS), surface motive (SM) and surface strategy (SS). The value of these variables is also the average of the questions included in the corresponding category. The rationale to use these two instruments relates to their demonstrated capacity to provide indicators of academic performance and learning process [3, 22]. These instruments can therefore, assist in identifying the indicators most relevant for explaining the adoption of video annotation.

Dependent Variable. The dependent variable MID is the score obtained in the midterm exam that consisted of 20 multiple choice questions about the material covered in the first five weeks of the course. The scores on this exam range from zero to 20 (all questions had the same value).

3.5 Data Analysis

Data analysis was performed by using linear regression modelling. In our analysis, we created three models with the midterm marks as the dependent variable. The first model had only the binary variable representing the use of CLAS for video annotations. This model was created to compare the increase in the variability explained by the association between the use of CLAS and the midterm marks compared to the variability explained by the other two models. The second and third linear regression models included the five MSLQ and four SPQ variables, respectively, within the first model to investigate: i) whether the association between CLAS use for video annotation and midterm marks persisted over and above the MSLQ and SPQ measures; and ii) whether the proportion of that association is explained by the constructs measured by MSLQ and SPQ. Unstandardized beta (B), standard error (SE) and standardized β coefficients for the independent variables and the R^2 values are reported for all three regression models. Results were considered significant if $p < .05$. All statistical tests were performed using the R software environment.

4. RESULTS

The descriptive statistics of each variable used in our study are shown in Table 1. The first linear regression model shown in Table 2 was obtained as a reference point to verify that a linear relation between the midterm score and the level of engagement with the video annotation tool was statistically significant. As it can be seen, although the coefficient of the linear model is statistically significant, it only accounted for slightly above 5% (R^2=0.052).

The second model presented in Table 3 was computed combining the use of the video annotation tool with the values of the five dimensions of the MSLQ test. The association between the tool use and the performance was held even after controlling for the MSLQ variables. The value of R^2 indicated that the model explained more than 13% of the variation. In addition, significant and negative effects of the two covariates were observed – cognitive strategy and test anxiety. While the negative effect for test anxiety was anticipated, the effect for cognitive strategy use was not. Students with higher scores of self-reported cognitive strategy use can be seen to be more "hesitant" or reluctant to adopt a new learning tool or approach (e.g. annotating videos). Moreover, we found a significant (yet weak) correlation (r=-0.161, p=0.50) between the scores of cognitive strategy use and the scores on the midterm exam. These findings suggest that the instructional design needs to offer some further guidance to the students on how to use the new tool effectively and provide a clear rationale outlining the value that such tool use can play in facilitating student learning and therefore, future academic performance. In a recent study, Gašević et al [10] demonstrated that by altering the external conditions (i.e. graded versus non-graded) had a significant impact on the quality and quantity of video annotations made in a course. The authors suggested that the graded condition translated into a scaffolded structure that essentially provided sufficient motivation and time for students to develop an understanding of how the technology can be best applied to aid their learning process. In this context, the participatory nature of the current case study essentially lacked the necessary impetus for students with established and effective cognitive strategies to experiment and adopt an alternate process.

Table 1. Descriptive Statistics of the variables of the study

Variables	Mean (SD) Entire sample (N=149)	Mean (SD) CLAS Users (N=41)	Mean (SD) CLAS Non-Users (N=108)
MID	14.09 (3.61)	15.43 (3.19)	13.58 (3.64)
CLAS USE	2.09 (4.28)	7.61 (4.97)	0.00 (0.00)
IVAL	5.31 (0.89)	5.40 (0.92)	5.27 (0.87)
SEFF	4.63 (0.99)	4.67 (1.01)	4.62 (0.99)
TANX	3.63 (1.36)	3.60 (1.47)	3.64 (1.32)
CSUS	4.80 (0.69)	4.70 (0.78)	4.84 (0.66)
SREL	4.66 (0.75)	4.59 (0.84)	4.69 (0.72)
DM	4.50 (1.00)	4.41 (1.07)	4.53 (0.97)
DS	4.50 (0.93)	4.38 (1.06)	4.54 (0.88)
SM	3.12 (1.21)	2.80 (1.26)	3.25 (1.17)
SS	3.72 (1.08)	3.58 (1.13)	3.77 (1.06)

Table 2. Model 1: Association between CLAS use and midterm marks

Coeff	Unstandardized coefficients B ± SE	Standardized coefficients β	t-value	p-value
Intercept	13.58 ± 0.34	-	40.03	**<0.001**
CLAS Use	1.85 ± 0.65	0.23	2.86	**<0.005**
R^2 = 0.0528, F(1, 147) = 8.195, p = 0.005, VIF = 1.00				

Furthermore, strategies that reduce students' test anxiety are necessary, even in the context of flipped classrooms which offer more opportunities to actively engage students. Further research examining the association between academic performance, cognitive strategy use, and tool use is needed. It may be the case that there is an indirect effect of cognitive strategy use on academic performance mediated by the tool use. In that mediation, the count of activities (e.g. annotations) may not be the best proxy of learning effort and motivation as shown in study by Devolder et al. [8]. The authors demonstrated that the time spent on self-regulated learning with an online learning system mediated the effect of learning experience with the tool on academic performance.

Table 3. Model 2: Association between CLAS use and the midterm marks after controlling for the five MSLQ scales

Coeff	Unstandardized coefficients B ± SE	Standardized coefficients β	t-value	p-value
Intercept	17.92 ± 2.34	-	7.655	**<0.001**
CLAS Use	1.60 ± 0.64	0.20	0.6406	**0.013**
IVAL	0.32 ± 0.46	0.08	0.696	0.488
SEFF	0.33 ± 0.38	0.09	0.870	0.387
TANX	-0.51 ± 0.22	-0.19	-2.287	**0.024**
CSUS	-1.21 ± 0.61	-0.23	-1.989	**0.049**
SREL	0.03 ± 0.54	0.01	0.059	0.953
$R^2 = 0.1341$, $F(6, 142) = 3.664$, $p = 0.002$, VIF =1.154				

Table 4. Model 3: Association between the use of CLAS and the midterm after controlling for the SPQ scales (DM, DS, SM, SS).

Coeff	Unstandardized coefficients B ± SE	Standardized coefficients β	t-value	p-value
Intercept	17.59 ± 1.77		9.947	**<0.001**
CLAS Use	1.65 ± 0.64	0.21	2.570	**0.011**
DM	-0.24 ± 0.40	-0.07	-0.595	0.553
DS	0.09 ± 0.42	0.02	0.217	0.829
SM	-0.05 ± 0.38	-0.02	-0.133	0.894
SS	-0.85 ± 0.42	-0.25	-2.028	**0.044**
$R^2 = 0.1287$, $F(5, 143) = 4.224$, $p = 0.001$, VIF = 1.148				

The final model represented in Table 4 was obtained by entering the four dimensions of the SPQ questionnaire. In this case, only one factor, surface strategy (aside from the use of CLAS), was statistically significant with a negative coefficient. This model accounts for slightly below 13% of the variation of the dependent variable. The main conclusion derived from this model is that the students who engaged with CLAS (e.g., made annotations) but retained a surface strategy towards learning had lower midterm scores. As in the case of Model 2, these associations suggest that in order to increase midterm results, some measures to promote a deeper approach to learning are required.

5. CONCLUSION

Video annotation tools to support learning are becoming common in multiple learning experiences. Although the use of videos by students should have a positive impact in their learning, there are few studies that investigate the connection between video annotation and student approaches to learning. The relation between grades and quantitative data automatically collected has been explored in the past. However, a more nuanced analysis is needed that takes into account how students approach the overall learning experience to put the data in the right context. This paper has presented a case study establishing an association between indicators of student strategies for learning and the use of a video annotation tool, CLAS in a flipped learning environment. A simple initial model showed a weak association between academic performance in a mid-term examination and the use of video annotations. However, when including the results of the MSLQ and SPQ questionnaires, the models provide statistically significant associations with some of the learning strategies. The results highlight the potential of combining automatically collected data with data self-reported by the students. The two instruments used to collect self-reported information (MSLQ and SPQ) are well established mechanisms to gauge the learning strategies adopted by learners. The results discussed in the paper offer insight on how to approach the use of video annotation technology in a real class and provide students with the adequate scaffolding to maximize its use.

As future research, we plan to widen the analysis in several directions. First, a more comprehensive set of factors within the course will be considered to study the effect of deploying the changes suggested by these initial findings. Second, the study will be extended to other learning contexts with different students and not a flipped learning environment. Finally, we plan to include in the study the effect of assessment strategies to see the influence in student engagement.

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