Investigating Behavioral Patterns of Procrastinators in a Wiki-based Activity

Abstract

Procrastination is one of the issues affecting more than half of the student population and is known to impact them negatively. It is also one of the major reasons for failure and dropout. Therefore, several studies have been conducted in this domain to understand when and why students procrastinate. The existing studies use self-reported procrastination scales and/or digital traces of student interactions recorded in learning environments to identify procrastination behavior. The majority of the extant studies leverage individual tasks such as assignments submission, quizzes attempted, course materials assessed by a student, etc, to study such behaviour. This paper uses group-based collaborative wiki activity to explore the procrastination behavior among the students. This study will help us explore student behavior in a group activity. The results would help us investigate if the student's behavior changes when it comes to a group activity. The results would be beneficial for instructors, practitioners, and educational researchers to know if group activity could be utilized to overcome procrastination behavior.

1   Introduction

Procrastination is an intentional delay of activity. Procrastination is derived from the Latin word 'Procrastinatus', meaning 'to put off until tomorrow'. It is a behavior that is considered unfavourable and is known to have a negative influence on the procrastinator. Several studies reveal it is common among students to delay study and learning-related activities (Kim and Seo, 2015, Steel and Klingsieck, 2016) and that at least half of them (Solomon and Rothblum, 1984, Ebadi and Shakoorzadeh, 2015) procrastinate. Subsequently, it has been widely studied in the academic context by researchers in psychology and education. Hence, the term academic procrastination or student procrastination (Solomon and Rothblum, 1984, Beswick et al., 1988) was coined and is defined as "to voluntarily delay an intended course of study-related action despite expecting to be worse off for the delay" (Steel and Klingsieck, 2016).

Academic procrastination is a learner behavior that is of major concern for instructors both in the classroom and online settings. It negatively influences academic outcomes (Klingsieck et al., 2012), impacts performance (Steel and

Klingsieck, 2016, Tuckman, 2002) lowers goal attainment (Morford, 2008), diminishes self-esteem (Harrington, 2005) reduces long-term learning (Schouwenburg and Lay, 1995), leads to stress (Tice and Baumeister, 1997), discomfort (Flett et al., 2012), lowers life satisfaction (Deniz, 2006), causes depression and anxiety (Rozental et al., 2015), as well as affects subjective well-being (Klingsieck et al., 2012). Moreover, procrastination is shown to be correlated with reduced use of cognitive and meta-cognitive learning strategies (Howell and Watson, 2007). Several studies have found procrastination as a major threat (Yang et al., 2020) and one of the major reasons for failure and dropout (Richardson et al., 2012), and dealing with it is one of the high-priority concerns in online learning settings (Goda et al., 2015, Cerezo et al., 2017). Therefore, studies on procrastination have been the focus of researchers for over a century. Studies have been conducted by psychologists and other researchers to determine procrastinating behavior, understand why people tend to procrastinate, what are the outcomes of such behavior and how can it be overcome.

Procrastination might be an individual trait (which would predict that students with a tendency to procrastinate would show similar behavior across all their higher education studies) or situational (where the students might procrastinate more on some tasks than others). While procrastination has predominantly been considered dysfunctional or irrational, several researchers have explored it as a functional delay (Klingsieck, 2013, Yamada et al., 2017). Chu and Choi (2005) categorized it into passive procrastination and active procrastination. While passive procrastinators hold an indecisive behavior to perform a task, active procrastinators make deliberate decisions to procrastinate because they prefer to work under pressure. Active procrastination offers positive outcomes as opposed to negative ones in the case of passive procrastination.

To determine procrastination, different measures have been used such as self-reported procrastination scales or behavioral measures. Behavioral measures can be recorded manually through observation (Steel et al., 2001) or collected via digital traces of interaction between student and learning environment (Cormack et al., 2020). Educational Data Mining (EDM) and Learning Analytics (LA) techniques are used to analyze digital traces/logs collected from Learning Management Systems (LMS) or Technology Enabled Learning Environments (TELE) and other learning environments (Cormack et al., 2020, Hooshyar et al., 2020).

Motivation

Extant studies conducted to date identify procrastinating behavior either using self-reported questionnaires or behavioral data logs recorded in LMS and find its relationship with performance. The existing studies determine procrastination majorly on individual tasks. It might be possible that procrastinating behavior might be different when individuals work collaboratively rather than individually.

Moreover, research studies have shown that the learning gain in the group is significantly better than individual students. Therefore, it would be vital to investigate the behavior of procrastinators when they work in a group-based collaborative activity and identify the behavioral patterns of different types of procrastinators when they work in collaboration. Hence, in this study, we explore the behavioral patterns of different types of procrastinators in a group-based collaborative Wiki activity. This study uses the self-reported Tuckman Procrastination scale to determine different types of procrastinators (low, moderate and high). It then extracts behavioral data of the Wiki activity that is recorded in Moodle LMS to investigate the actual behavioral patterns of different types of procrastinators. This study also examines procrastination behaviour within student groups.

Structure of the Paper

The rest of this paper is structured as follows: Section II discusses related works, and the wiki assignment is described in Section III. The research Methodology and study design are detailed in Section IV. This is followed by Section V which covers descriptive statistics and results. The results are discussed in Section VI, and Section VII discusses the limitations of our work and concludes this paper with future work.

2 Related Work

Procrastination behavior has been measured in a variety of ways. Several researchers have developed procrastination scales such as General Procrastination Scale (Lay, 1986), Tuckman Procrastination Scale (TPS; (Tuckman, 1991), Adult Inventory of Procrastination (McCown and Johnson, 1989), and Academic Procrastination Scale (Milgram and Toubiana, 1999). While those determine procrastination from a negative perspective, Active Procrastination scale (Choi and Moran, 2009) measures it from a positive viewpoint. Several researchers utilised these scales in their studies to measure procrastination. For instance, Goroshit (Goroshit, 2018) used the Studying Procrastination Scale developed by Wohl, Pychyl, and Bennett (Wohl et al., 2010), Tuckman (Tuckman, 2005) and Michinov et al (Michinov et al., 2011) used Tuckman Procrastination Scale, Klingsieck et al. (Klingsieck et al., 2012) used General Lay procrastination scale in their research to study procrastination.
With the emergence of LMS and proliferation of online learning, researchers are using behavioral data as a proxy measure of procrastination. These generally include assignment submission time (Cormack et al., 2020, Tani, 2017), time of first activity (Cerezo et al., 2017), pace of accesses (Jo et al., 2016), task completion time (Levy and Ramim, 2012), number of clicks, time spent until first activity (Paule Ruiz et al., 2015), variables related to effort and time spent working

(Cerezo et al., 2017). Earlier, such behaviour was recorded manually through observation (Steel et al., 2001), but now, researchers majorly extract digital traces from learning sites and then use EDM and LA techniques to find useful patterns and relationships among variables. Researchers have used diverse measures to determine procrastination behaviour of students. For instance, several researchers utilised LMS logs to fetch data on the time of assignment submissions to measure procrastinaton. Hooshyar et al.(Hooshyar et al., 2020) used inactive and spare time as a measure of procrastination. While others (Cormack et al., 2020) (Tian et al., 2019) have taken assignment submission time or have calculated it as the average ratio of the interval between the submission time and the release time of each assignment and the interval between the deadline and the release time. Akram et al. (2019) used time to start and end the assignment as a measure. Goda et al. (Goda et al., 2015) considered time spent in learning materials as well as completion rates to determine procrastination. Yamada et al. (Yamada et al., 2017) and (Yamada et al., 2016) used a 2 x 2 time-related academic behavior self-reported scale as well as logs to find the average submission time and late submission time in reports and a 1-minute paper. Hensley (Hensley, 2014) used both self-reported scales (Tuckman Procrastination Scale, Active Procrastination Scale, Procrastination Assessment Scale-Students) and homework quizzes submission time to determine procrastination. Lee (Lee and Nichol, 2017) used both self-reported scale (Tuckman Procrastination Scale) and logs from a discussion forum for measuring procrastination. The factors included how long the student waited to complete the questionnaire, how long students took to make their first discussion post each week, number of days to complete the questionnaire, and how long students waited to make their discussion posts. Yang et al. (Yang et al., 2020) used the homework submission patterns, Paule-Ruiz et al. (Paule Ruiz et al., 2015) considered tasks (assignments, resources, quizzes) delay to determine procrastination. Other groups of researchers (Cerezo et al., 2016, Cerezo et al., 2017, Elvers et al., 2003, Lim, 2016) have used days (activity start date, activity end date and days in hand) as a factor to measure procrastination. Their analysis was based on the actions performed by the student during a practical activity, in a forum or general behaviour in LMS. Park et al. (Park et al., 2018) took regularity (individual week daily activity count, aggregated Daily task count) as a factor. They used clickstream data based on activities (such as watching a lecture video or submitting a quiz) performed by the student. AlJarrah et al. (AlJarrah et al., 2018) used the number of clicks and days when the material was accessed as a way to determine procrastination. Elvers et al. (Elvers et al., 2003) used the difference between the date when the materials were first accessed and the date of the exam as the basis of measuring procrastination. You (You, 2015) has taken frequency of late assignment submissions to identify procrastinating behaviour of a student.

The existing studies depict that the researchers have studied procrastination for independent tasks such as the time when the individual submits an assignment or

4

completes an activity, time to start an activity by an individual, etc; thus focusing on tasks that are performed in solidarity. Recently a research study analysed on how student's procrastination will differ between individual and group for an assignment task. In this study (Koppenborg and Klingsieck, 2022), authors compared the duration of task and number of errors in the assignment between individual and group. The results shows that students while work in a group exhibit less procrastination compared to while work individually. However, in this study (Koppenborg and Klingsieck, 2022), authors selected only students with high procrastination traits. In this study we propose to explore how students change their procrastination when they work in group and collaborative activity such as creating wiki page in an LMS. This study analyzes the behaviour of the students in wiki and identify if grouping different types of procrastinators in a group changed their behaviour. This study depicts this behaviour using descriptive analytics.

3   Background: Wiki

Wiki is one of the common tools for computer-supported collaborative learning (Elgort et al., 2008). Wikis are sets of interlinked web pages, created through the incremental development collaboratively by a group of users situated at different locations (Leuf and Cunningham, 2001) . The users can create new pages, add content, reorganize information to the existing pages, as well as create links between existing and new pages. One of the distinguishing features of wiki is that it is possible to keep record of different versions of wiki documents created by each user. Every single contribution made by each user to a wiki page generates a new version of a page and is recorded. Thus, it is possible to track edits, determine the difference between two consecutive wiki versions and restore previous versions (TREnTIn, 2009, Balderas et al., 2018). Consequently, it is possible to analyze these recorded wiki logs to examine the behavior of each student on a wiki assignment. Subsequently, this study aims to use these wiki logs to analyze the behavior of different types of procrastinators.

There are a few studies that attempt to find effectiveness of wiki for different types of activities (Elgort et al., 2008, TREnTIn, 2009), use of wiki as a tool for measuring engagement (Stanca and Felea, 2016) and enhancing learning (Tsai et al., 2010; Wang, 2016). Few authors find an association between wiki activities and grades. For instance, Conijn et al (2016) found no such relationship but L´opez-Zambrano et al. (L´opez-Zambrano et al., 2020) found a relationship between wiki and grade. While other studies are focused on finding the assessment technique for review of wiki assignment (De Wever et al., 2011); (Lai and Ng, 2011)). This study uses Wiki to explore the procrastination behaviour of the students in a collaborative group activity.

4   Research Objectives and Questions

The objective of this research was to

1. examine patterns of students' behavior in a wiki activity using logs of a Moodle LMS

2. determine if there are significant differences among different types of procrastinators

3. explore the behavioral patterns of different types of procrastinators within the student groups

This study attempts to use the collaborative work performed in a wiki environment to examine student behavior. This study will explore the behaviour between and within different groups of procrastinators.

5   Materials and Methods

For this research study, a group-based Wiki activity "Evolution of JAVA," was designed on Moodle LMS. The participants were 4th-semester undergraduate Computer Science & Engineering students at an Indian University. The class consisted of fifty students from the Java Programming course. The students were divided into nine groups (sequenced A to I) with 5 to 6 members in each. At the beginning of the semester, the students were requested to fill out a questionnaire consisting of statements from the 16-item Tuckman Procrastination Scale (Tuckman, 1991]. Tuckman questionnaire is a 4-point Likert scale ("That's me for sure; That's me; That's not me; That's not me for sure") and the scores can range from 16-64, with higher scores indicating a greater tendency to procrastinate. All the students consented to participate in the research. Their names have been anonymized for research purposes.

Before the start of Wiki assignment, a 30-minutes hands-on training on creating Wiki pages on Moodle LMS was given to the students on MS Teams. The students were then briefed about the requirements of the wiki activity. A discussion forum was also created on Moodle LMS for facilitating discussions among the students. Due to Covid-19, the session was completely online/remote, and the classes were conducted synchronously. Therefore initially, breakout rooms were created on MS Teams to facilitate discussions among the group members. The faculty participated in each breakout session to enable discussions and clear any doubts among the group members. This session lasted for 50 minutes. The students were then required to complete the wiki assignment from 24th December 2020 at 11:59 AM to 10th January 2021 at 11:59 PM.

There were two students who did not fill out the survey and two did not perform any Wiki activity on LMS hence three students were excluded from the study resulting in a total of forty-seven students. One of the students who was excluded

from the study was a high procrastinator which is evident as he did not perform even a single activity on the wiki page.

Data Pre-Processing

The logs for the wiki activities were gathered from Moodle LMS. The data was then transformed as per the requirements for analysis. The names were anonymized and the entries for the student who did not fill out the questionnaire were removed. Timestamp was converted to date-time format and split into data and time. The dates were changed to day number. For instance, the date 24th December 2020 was changed to Day 1 and 10th January 2021 to Day 18. Additional columns were added to the logs to determine the relevant procrastination category (low, moderate, high) and wiki group (A-I). Grouping was done based on the procrastination type, event name, date, and time. Python pandas were used for this data cleaning and transformation. The detailed analysis was done using Tableau and SPSS.

6   Descriptive Statistics and Results

Descriptive analysis

We computed Cronbach's alpha value to confirm the reliability the Tuckman scale and the alpha = 0.851 value found to be reliable. Moreover, the total scores were normally distributed as depicted by Shapiro-Wilk's test ($p > 0.05$) (Shapiro and Wilk, 1965, Razali et al., 2011). The visual representation of their histograms, normal Q-Q plots and box plots showed that all the scores with a skewness of 0.207 (SE = 0.347) and kurtosis of -0.307 (SE=0.681) (Cramer and Howitt, 2004, Doane and Seward, 2011). Actual score ranged from 16 to 50 with a mean of 31.87 (SD=7.63). The students were categorized as high, moderate, and low procrastinators based on a tertile split (Tuckman, 2002). Quartiles were used for splitting the data into three groups and shown in table 1.

Table 1: Categorization of students based on the Total scores.

Scores	Categories	Number of students in each category	Percentage of students in each category
16-28	Low Procrastinators	18	38.2%
29-36	Moderate Procrastinators	17	36.2%
>36	High Procrastinators	12	25.6%

Result Analysis

7

The aim of this study is to examine the

- Differences among different types of procrastinators

- Behavioral patterns of different groups of procrastinators

To answer our first research question that is how different type procrastinators interact with Wiki tasks in an LMS, we first analyse frequency of action performed by different type of procrastinators. Secondly, we explore the difference in when the activity was performed (regularly or close to the deadline) by different types of procrastinators.

6.1   *Differences among different types of procrastinators*

In order to find the difference among the types of procrastinators we examine the difference in frequency of actions performed by different types of procrastinators. We computed the average number of activities by each type of learner and shown in Table 2. From the table it is evident that the low procrastinators performed the maximum number of activities followed by moderate and then high procrastinators.

Table 2: Number of wiki activities performed by different groups of procrastinators.

Category	Low Procrastinators	Moderate Pro-crastinators	High Procras-tinators
Total number of Wiki activities	3843	2136	1169
Average number of Wiki activities	213.5	125.65	97.4

To analyse further, from Moodle log data we extracted activities related to wiki, they are number of Wiki pages created, viewed, updated, wiki history, page version, and map viewed, wiki difference viewed, page locks deleted, version restored, number of course module and comments viewed. Then we compared the frequency of each wiki activities among three types of procrastinators (low, moderate and high) and shown in table 3.

From the table 3 it is evident that low procrastinators have performed the wiki activities more frequently compared other two types of procrastinators. In order the establish statistical significance among the difference in frequency of actions performed by types of procrastinators we computed chi-square test, and the results indicates that there is a relationship between number of wiki activities performed and the three types of procrastinators X2 (10) = 77.866, $p < .05$, also shown in Table 4. For analysis, the activities with frequency less than 5 were removed.

The difference between the average number of activities by different types of procrastinators are show in the figure 1.

Figure 1 depicts the activity behavioral patterns showing the frequency of distinct activities performed by different types of procrastinators. It is evident from the graphs that overall low procrastinators dominated in performing almost all wiki activities. Next the question arises, when did different type of procrastinators perform the activities. Whether the activities are performed regularly or performed only close to the deadline.

Table 3: Frequency and Average of each Wiki activity for Low, Moderate and High procrastinators

	Tuckman Level		
Event Name	**Low N(Mean)**	**Moderate N(Mean)**	**High N(Mean)**
Wiki page viewed	1934 (107.44)	887 (52.18)	531 (44.25)
Course module Viewed	608 (33.78)	444 (26.12)	200 (16.67)
Wiki page locks Deleted	561 (31.17)	318 (18.71)	190 (15.83)
Wiki page updated	534 (29.67)	297 (17.47)	185 (15.42)
Wiki history Viewed	57 (3.17)	73 (4.29)	20 (1.67)
Wiki page created	60 (3.33)	48 (2.82)	15 (1.25)
Wiki page map Viewed	69 (3.83)	19 (1.12)	14 (1.17)
Comments viewed	15 (0.83)	18 (1.06)	11 (0.92)
Wiki diff viewed	4 (0.22)	24 (1.41)	2 (0.17)
Wiki page version viewed	1 (0.06)	7 (0.41)	0 (0.00)
Wiki version re-Stored	0 (0.00)	1 (0.06)	1 (0.08)

Table 4: Chi-Square Tests between wiki actions by different types of Procrastinators

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	77.866a	10	.000

Likelihood Ratio	75.154	10	.000
Linear-by-Linear Association	13.854	1	.000
N of Valid Cases	6962		
a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 20.16.			

Temporal nature of wiki activities performed by different types of procrastinators

In order to analyse the difference between different type of procrastinator's activities in Wiki, we computed the number of activities per day by each learner. Table 5 shows the number of activities done by different types of procrastinators each day and also the average by Low, Medium and High procrastinators. From the table it is clear that both low and moderate procrastinators were regular with their assignment compared to high procrastinators. Day 1 indicates the starting day of the Wiki task and Day 18 is the
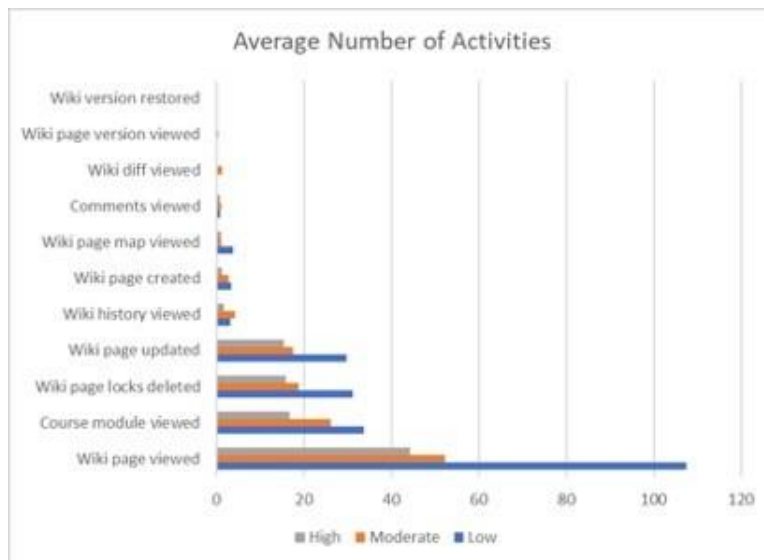

Figure 1: Average number of Wiki Action by different types of Procrastinators

deadline to complete the task. Day 2 is a holiday (25th Dec 2020) and Day 4 is Sunday. From the table, we can see that Low and Moderate type of learners performed few activities initially then they started more activities from day 8 or day 9. On the contrary, high procrastinators were not very active until the 15th day. There were just a fraction of activities carried out by them before that.

However, there are more activities close to the deadline irrespective of the type of procrastinator. For low procrastinators, we can go by the theory of Chu and Choi (2005) that argues that there might be active procrastinators who focus on perfectionism and might continuously add and upgrade content for enhancing the quality of Wiki pages. Overall, the number of activities performed by low procrastinators was greater followed by moderate and then high procrastinators. Although some high procrastinators did a few activities on the first day but started with the assignment late.

We also plotted the data in Figure 2. The figure clearly shows that low procrastinators were regular and carried out a maximum number of activities followed by moderate and high procrastinators. The number of activities is highest towards the deadline. Also, Day 18 being the last day, maximum work was done on this day. There were very few students who extended their work beyond the deadline.

6.2   Within-Group Analysis

In this subsection, we explore the difference in students' behaviour in each group. Since the groups are randomly assigned before we administrated the Tuckman Scale, each group had a mix of different types of procrastinators as shown in

Table 5: Frequency and Average of Activities performed in each Type of Procrastinators in Day-wise. Day 1 indicates first day of activity and Day 18 is the deadline to complete the activity.

	Tuckman Based Type		
Activity Day	Low (Avg)	Moderate (Avg)	High (Avg)
Day 1	27 (1.50)		9 (0.75)
Day 3	81 (4.50)	66 (3.88)	
Day 4		5 (0.29)	
Day 5	49 (2.72)	12 (0.71)	
Day 6	4 (0.22)	7 (0.41)	1 (0.08)
Day 7	10 (0.56)	12 (0.71)	4 (0.33)
Day 8	67 (3.72)	20 (1.18)	3 (0.25)
Day 9	84 (4.67)	15 (0.88)	17 (1.42)
Day 10	23 (1.28)	95 (5.59)	10 (0.83)
Day 11	54 (3.00)	45 (2.65)	16 (1.33)
Day 12	128 (7.11)	32 (1.88)	

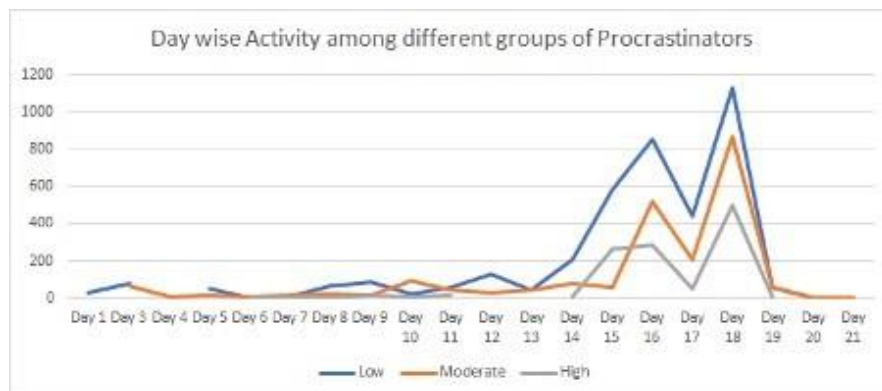|			
Day 13	42 (2.33)	42 (2.47)	
Day 14	208 (11.56)	80 (4.71)	7 (0.58)
Day 15	583 (32.39)	56 (3.29)	262 (21.83)
Day 16	851 (47.28)	519 (30.53)	288 (24.00)
Day 17	443 (24.61)	204 (12)	47 (3.92)
Day 18	1129 (62.72)	866 (50.94)	499 (41.58)
Day 19	59 (3.28)	58 (3.41)	6 (0.50)
Day 20	1 (0.06)	1 (0.06)	

Figure 2: Line graph showing the day the activity was started by each group.

Table 6: Tuckman based types of students in each group

	Tuckman Based Type			
Group ID	**Low**	**Moderate**	**High**	**Total**
Group A	1	2	2	5
Group B	2	2	1	5
Group C	2	3	1	6
Group D	1	3	1	5
Group E	1	3	2	6
Group F	2	2	1	5
Group G	3	3	0	6

12

Group H	4	0	1	5
Group I	1	0	2	3

Table 7: Average Number of activities by types of procrastinators (group-wise)

	Tuckman Based Type		
Group ID	**Low**	**Moderate**	**High**
Group A	165	103.5	145
Group B	87.5	77.5	207
Group C	161	148.67	66
Group D	89	204	40
Group E	318	113	14.5
Group F	89.50	64.5	64

Table 6. Since Group G, H and I don't represent all types of learners, we considered on Group A to F for the analysis.

To explore the behavioral differences among the diverse group of students, we considered the number of activities of each group. The average number of activities by each group is shown in table 7.

The previous sections depicted the activity patterns based on the type of procrastinators (low, moderate, high) and revealed that low procrastinators performed comparatively more activities when compared to moderate and low procrastinators. However, exploration of data (Table 7) indicates that it is difficult to generalise the assumption regarding procrastination behaviour within the group. For instance, in Group B, high procrastinator/s performed more tasks on average compared to low and moderate peers, for Group D, moderate procrastinators, on average, carried out much more activities than the low procrastinators. Hence, we investigate the within-group behaviour based on the time when the activities were performed to get better insights into the behaviour of different types of procrastinators within each student group.

Line graph (figure 3) shows that Groups A, B, and E were more regular with their work compared to the other groups. Group F start the work close to the deadline. Figure 3 also indicates that Group E had only one low procrastinator, but s/he carried out most of the activities. High procrastinators in Group D
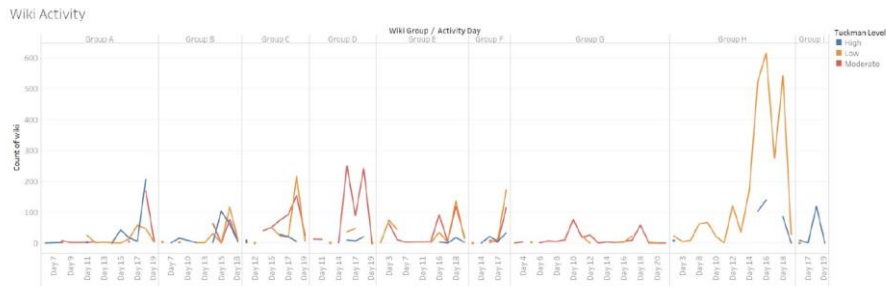
Figure 3: group-wise pattern of different types of procrastinators

performed fewer activities and that too close to the deadline. The behaviour of those groups supports our assumption that low procrastinators are regular and high procrastinators are not. However, for Group A and B this does not hold. The high procrastinators are as regular as the low and moderate peers as well as perform more activities. For Group C, moderate procrastinators are more frequent with activities throughout the assignment.

7   Discussion

This paper was an attempt to investigate the procrastination behaviour of the students, specifically when they work in a group-based collaborative wiki activity. It was assumed that the low procrastinators would outperform the moderate and high procrastinators in the total number of activities and regularity of work. When the three types of procrastinators (low, moderate and high) were compared cumulatively, the findings supported our assumptions. These result findings are in-line with the previous studies performed on individual tasks and suggest that low procrastinators are more active than moderate and low procrastinators or that the non-procrastinators are more consistent and early starters compared to the non-procrastinators. It was further assumed that when diverse types of procrastinators are put in a group, their behaviour might change. However, no generalised statement can be formed while examining with-in group behaviour. A further assumption that individual behaviour might not change even when different types of procrastinators are put in a group is also not supported. Few groups (E) support the assumption that the low procrastinators are regular and perform more activities. None of the assumptions regarding the student behaviour for the group-based collaborative wiki activity could be established during with-in the group analysis. The discrepancies could be due to several reasons. Firstly, this might be due to the self-reported procrastination scale where the students either did not report their actual behaviour or were not sure about their behaviour. Therefore, it might have been useful to categorise the students

14

based on their actual behaviour recorded in the LMS logs rather than relying on self-reported questionnaires. There might be a shortcoming in the way, the groups were formed as the students were given a chance to form their own groups based on their convenience. As the assignment was given during the Christmas and New Year time, the students might have been busy with celebrations. Furthermore, it might be the case that some student was suffering from COVID-19 or other illness and hence could not actively participate. Such cases were not reported to the instructor. The actual reasons for inactive participation are not known.

8 Conclusion

This study tried to identify the procrastination behaviour when it comes to group-based Wiki activity. This was different from the previous studies that emphasized individual activities to study students' procrastination behaviour. Although it is difficult to form any assumption with the current dataset, this study opens the pathway to conduct further studies, with a larger, more planned and structured categorisation of the students into different groups. There were a few limitations of this work that could be addressed in future work. Firstly, the quality of wiki posts is not taken into consideration. It would be worthwhile to explore the quality of the Wiki posts and wiki pages and compare it with the different types of procrastinators. Secondly, the duration for which the wiki activity was performed could not be gathered due to the limitations of Moodle. These could be addressed in future studies. It could be interesting to explore the difference between various types of procrastinators for individual versus group tasks. Additionally, it would be useful to utilise the LMS logs to study student behaviour rather than relying on the self-reported Procrastination scales. Also, multiple experiments on different types of group activities could be taken as some students might not be comfortable using Wiki. Additionally, the active procrastination scale by Chu and Choi (2005) could be used to identify active procrastinators.

Data Availability

The names of all the students have been anonymized. For the survey, consent has been taken from all the students. The datasets used for the current study are not publicly available but are available on reasonable request.

There is no conflict of interest.

References

Akram, A., Fu, C., Li, Y., Javed, M. Y., Lin, R., Jiang, Y., and Tang, Y. (2019). Predicting students' academic procrastination in blended learning course using homework submission data. *IEEE Access*, 7:102487–102498.

AlJarrah, A., Thomas, M. K., and Shehab, M. (2018). Investigating temporal access in a flipped classroom: procrastination persists. *International Journal of Educational Technology in Higher Education*, 15(1):1–18.

Balderas, A., Palomo-Duarte, M., Dodero, J. M., IbarraS´aiz, M. S., and Rodr´ıguez-G´omez, G. (2018). Scalable authentic assessment of collaborative work assignments in wikis. *International Journal of Educational Technology in Higher Education*, 15(1):1–21.

Beswick, G., Rothblum, E. D., and Mann, L. (1988). Psychological antecedents of student procrastination. *Australian psychologist*, 23(2):207–217.

Cerezo, R., Esteban, M., S´anchez-Santill´an, M., and Nu´n˜ez, J. C. (2017). Procrastinating behavior in computer-based learning environments to predict performance: A case study in moodle. *Frontiers in psychology*, 8:1403.

Cerezo, R., S´anchez-Santill´an, M., Paule-Ruiz, M. P., and Nu´n˜ez, J. C. (2016). Students' lms interaction patterns and their relationship with achievement: A case study in higher education. *Computers & Education*, 96:42–54.

Choi, J. N. and Moran, S. V. (2009). Why not procrastinate? development and validation of a new active procrastination scale. *The Journal of social psychology*, 149(2):195–212.

Chun Chu, A. H. and Choi, J. N. (2005). Rethinking procrastination: Positive effects of" active" procrastination behavior on attitudes and performance. *The Journal of social psychology*, 145(3):245–264.

Conijn, R., Snijders, C., Kleingeld, A., & Matzat, U. (2016). Predicting student performance from LMS data: A comparison of 17 blended courses using Moodle LMS. *IEEE Transactions on Learning Technologies*, *10*(1), 17-29.

Cormack, S. H., Eagle, L. A., and Davies, M. S. (2020). A large-scale test of the relationship between procrastination and performance using learning analytics. *Assessment & Evaluation in Higher Education*, 45(7):1046–1059.

Cramer, D. and Howitt, D. L. (2004). *The Sage dictionary of statistics: a practical resource for students in the social sciences*. Sage.

De Wever, B., Van Keer, H., Schellens, T., and Valcke, M. (2011). Assessing collaboration in a wiki: The reliability of university students' peer assessment. *The Internet and Higher Education*, 14(4):201–206.

Deniz, M. (2006). The relationships among coping with stress, life satisfaction, decision-making styles and decision self-esteem: An investigation with turkish university students. *Social Behavior and Personality: an international journal*, 34(9):1161–1170.

Doane, D. P. and Seward, L. E. (2011). Measuring skewness: a forgotten statistic? *Journal of statistics education*, 19(2).

Ebadi, S. and Shakoorzadeh, R. (2015). Investigation of academic procrastination prevalence and its relationship with academic self-regulation and achievement motivation among high-school students in tehran city. *International Education Studies*, 8(10):193–199.

Elgort, I., Smith, A. G., and Toland, J. (2008). Is wiki an effective platform for group course work? *Australasian Journal of Educational Technology*, 24(2).

Elvers, G. C., Polzella, D. J., and Graetz, K. (2003). Procrastination in online courses: Performance and attitudinal differences. *Teaching of Psychology*, 30(2):159–162.

Flett, G. L., Stainton, M., Hewitt, P. L., Sherry, S. B., and Lay, C. (2012). Procrastination automatic thoughts as a personality construct: An analysis of the procrastinatory cognitions inventory. *Journal of Rational-Emotive & Cognitive-Behavior Therapy*, 30(4):223–236.

Goda, Y., Yamada, M., Kato, H., Matsuda, T., Saito, Y., and Miyagawa, H. (2015). Procrastination and other learning behavioral types in e-learning and their relationship with learning outcomes. *Learning and Individual Differences*, 37:72–80.

Goroshit, M. (2018). Academic procrastination and academic performance: An initial basis for intervention. *Journal of prevention & intervention in the community*, 46(2):131–142.

Harrington, N. (2005). It's too difficult! frustration intolerance beliefs and procrastination. *Personality and Individual Differences*, 39(5):873–883.

Hensley, L. C. (2014). Reconsidering active procrastination: Relations to motivation and achievement in college anatomy. *Learning and Individual Differences*, 36:157–164.

Hooshyar, D., Pedaste, M., and Yang, Y. (2020). Mining educational data to predict students' performance through procrastination behavior. *Entropy*, 22(1):12.

Howell, A. J. and Watson, D. C. (2007). Procrastination: Associations with achievement goal orientation and learning strategies. *Personality and Individual Differences*, 43(1):167–178.

Jo, I.-H., Park, Y., Yoon, M., and Sung, H. (2016). Evaluation of online log variables that estimate learners' time management in a korean online learning context. *International Review of Research in Open and Distributed Learning*, 17(1):195–213.

Kim, K. R. and Seo, E. H. (2015). The relationship between procrastination and academic performance: A meta-analysis. *Personality and Individual Differences*, 82:26–33.

Klingsieck, K. B. (2013). Procrastination in different lifedomains: is procrastination domain specific? *Current Psychology*, 32(2):175– 185.

Klingsieck, K. B., Fries, S., Horz, C., and Hofer, M. (2012). Procrastination in a distance university setting. *Distance Education*, 33(3):295–310.

Koppenborg, M. and Klingsieck, K. B. (2022). Group work and student procrastination. *Learning and Individual Differences*, 94:102117.

Lai, Y. C. and Ng, E. M. (2011). Using wikis to develop student teachers' learning, teaching, and assessment capabilities. *The Internet and Higher Education*, 14(1):15–26.

Lay, C. H. (1986). At last, my research article on procrastination. *Journal of research in personality*, 20(4):474–495.

Lee, S. D. and Nichol, P. (2017). Does the effect of procrastination on academic performance differ based on course format?

Leuf, B. and Cunningham, W. (2001). *The Wiki way: quick collaboration on the Web*. Addison-Wesley Longman Publishing Co., Inc.

Levy, Y. and Ramim, M. (2012). A study of online exams procrastination using data analytics techniques. *Interdisciplinary Journal of E-Learning and Learning Objects*, 8(1):97–113.

Lim, J. M. (2016). Predicting successful completion using student delay indicators in undergraduate self-paced online courses. *Distance Education*, 37(3):317–332.

L´opez-Zambrano, J., Lara, J. A., and Romero, C. (2020). Towards portability of models for predicting students' final performance in university courses starting from moodle logs. *Applied Sciences*, 10(1):354.

McCown, W. and Johnson, J. (1989). Validation of an adult inventory of procrastination. *Society for Personality Assessment, New York*.

Michinov, N., Brunot, S., Le Bohec, O., Juhel, J., and Delaval, M. (2011). Procrastination, participation, and performance in online learning environments. *Computers & Education*, 56(1):243–252.

Milgram, N. and Toubiana, Y. (1999). Academic anxiety, academic procrastination, and parental involvement in students and their parents. *British Journal of Educational Psychology*, 69(3):345–361.

Morford, Z. (2008). Procrastination and goal-setting behaviors in the college population: An exploratory study. *Unpublished masters thesis, Georgia Institute of Technology. Retrieved April*, 16(2009):23–43.

Park, J., Yu, R., Rodriguez, F., Baker, R., Smyth, P., and Warschauer, M. (2018). Understanding student procrastination via mixture models. *International Educational Data Mining Society*.

Paule Ruiz, M. P., Riestra Gonz´alez, M., S´anchez Santill´an, M., P´erez P´erez, J. R., et al. (2015). The procrastination related indicators in e-learning platforms. *Journal of Universal Computer Science*.

Razali, N. M., Wah, Y. B., et al. (2011). Power comparisons of shapiro-wilk, kolmogorov-smirnov, lilliefors and anderson-darling tests. *Journal of statistical modeling and analytics*, 2(1):21–33.

Richardson, M., Abraham, C., and Bond, R. (2012). Psychological correlates of university students' academic performance: a systematic review and meta-analysis. *Psychological bulletin*, 138(2):353.

Rozental, A., Forsell, E., Svensson, A., Andersson, G., and Carlbring, P. (2015). Internet-based cognitive—behavior therapy for procrastination: A randomized controlled trial. *Journal of Consulting and Clinical Psychology*, 83(4):808.

Schouwenburg, H. C. and Lay, C. H. (1995). Trait procrastination and the big-five factors of personality. *Personality and Individual differences*, 18(4):481–490.

Shapiro, S. S. and Wilk, M. B. (1965). An analysis of variance test for normality (complete samples). *Biometrika*, 52(3/4):591–611.

Solomon, L. J. and Rothblum, E. D. (1984). Academic procrastination: frequency and cognitive-behavioral correlates. *Journal of counseling psychology*, 31(4):503.

Stanca, L. and Felea, C. (2016). Student engagement pattern in wiki-and moodle-based learning environments—a case study on romania. In *State-of-the-Art and Future Directions of Smart Learning*, pages 165–171. Springer.

Steel, P., Brothen, T., and Wambach, C. (2001). Procrastination and personality, performance, and mood. *Personality and individual differences*, 30(1):95–106.

Steel, P. and Klingsieck, K. B. (2016). Academic procrastination: Psychological antecedents revisited. *Australian Psychologist*, 51(1):36–46.

Tani, K. (2017). Academic procrastination and the effect on students' results for ict students. *International Journal of Cyber Behavior, Psychology and Learning (IJCBPL)*, 7(2):31–35.

Tian, H., Lai, S., and Wu, F. (2019). Does time play a role? prediction of learning performance with time-use habits in online assignments. In *2019 International Joint Conference on Information, Media and Engineering (IJCIME)*, pages 473–477. IEEE.

Tice, D. M. and Baumeister, R. F. (1997). Longitudinal study of procrastination, performance, stress, and health: The costs and benefits of dawdling. *Psychological science*, 8(6):454–458.

TREnTIn, G. (2009). Using a wiki to evaluate individual contribution to a collaborative learning project. *Journal of computer assisted learning*, 25(1):43–55.

Tsai, W.-T., Li, W., Elston, J., and Chen, Y. (2010). Collaborative learning using wiki web sites for computer science undergraduate education: A case study. *IEEE Transactions on Education*, 54(1):114–124.

Tuckman, B. W. (1991). The development and concurrent validity of the procrastination scale. *Educational and psychological measurement*, 51(2):473–480.

Tuckman, B. W. (2002). Academic procrastinators: Their rationalizations and web-course performance.

Tuckman, B. W. (2005). Relations of academic procrastination, rationalizations, and performance in a web course with deadlines. *Psychological reports*, 96(3 suppl):1015–1021.

Wang, L. (2016). Employing Wikibook project in a linguistics course to promote peer teaching and learning. *Education and Information Technologies*, 21, 453-470.

Wohl, M. J., Pychyl, T. A., and Bennett, S. H. (2010). I forgive myself, now i can study: How self-forgiveness for procrastinating can reduce future procrastination. *Personality and individual differences*, 48(7):803–808.

Yamada, M., Goda, Y., Matsuda, T., Saito, Y., Kato, H., and Miyagawa, H. (2016). How does self-regulated learning relate to active procrastination and other learning behaviors? *Journal of Computing in Higher Education*, 28(3):326–343.

Yamada, M., Oi, M., and Konomi, S. (2017). Are learning logs related to procrastination? from the viewpoint of self-regulated learning. *International Association for Development of the Information Society*.

Yang, Y., Hooshyar, D., Pedaste, M., Wang, M., Huang, Y. M., and Lim, H. (2020). Prediction of students' procrastination behaviour through their submission behavioural pattern in online learning. *Journal of Ambient Intelligence and Humanized Computing*.

You, J. W. (2015). Examining the effect of academic procrastination on achievement using lms data in e-learning. *Journal of educational technology & society*, 18(3):64–74.

Zhang, X. (2023). Peer pressure and web-based peer learning: an exploratory case study. *Education and Information Technologies*, 1-16.

Appendix

Wiki Assignment The students are required to design a Wiki Page/pages showing the 'Evolution of JAVA'. This is a group activity with a team of 5-6 students. The students need to show the evolution of Java right from inception. The students can support their work through images, diagrams, text, hyperlinks, etc. The page/s should be well organized and visually appealing. The sentences should be clear and grammatically correct. No jargon must be used. The information must be complete. You can divide the information yearwise or version wise as well as add the additional features added in each version. You can be as creative as you want. You must create a task descriptor that clearly demarcates the contribution of each team member.

Rules:

All the students/ team members of the group must collaborate and create a Wiki page on LMS. All the collaborative design efforts should be done on LMS. Your efforts would be recorded on LMS and so ensure equal and regular participation of all the team members. Before starting with the activity, you must go through Internet resources to learn about creating Wiki pages. The team would lose marks in case they paste the complete content in one go on LMS. Plagiarism among different teams or from any other resource is not acceptable. Each team will have to present their work in the class. Grading Parameters Quality of Design Adequacy of Topic History of Development Functionality Presentation Participation

The last date of submission of the Activity is 10th January 2020 by 11:59 PM. This activity would be graded and carries 30 marks.