Investigating Relationships between Undergraduate Students’ Flow Experience, Academic Procrastination Behavior, and Calculus Course Achievement

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ABSTRACT

Purpose: Calculus is generally offered as a freshman-year course and is a prerequisite for some advanced STEM-related courses in some undergraduate programs. However, some students experience difficulties in Calculus courses, leading to lower levels of achievement. Thus, there is a need to examine the factors which may be related to students’ achievement in Calculus courses. According to relevant literature, procrastination can diminish students’ achievement. Additionally, flow emerges as an important factor that may be related to students’ achievement and procrastination, but these relationships have not been studied in the context of Calculus courses.

The purpose of this study was twofold. Firstly, undergraduate students’ academic procrastination was examined in relation to dimensions of flow experiences in a Calculus-I course. Secondly, undergraduate students’ academic achievement in Calculus-I course was explored in relation to their academic procrastination and dimensions of flow experiences.

Research Methods: A total of 117 undergraduate students (54% female and 46% male, M_age=23.00) from various departments participated in an online survey. Findings: Multiple regression analysis showed that among flow-experience dimensions, “concentration on the task at hand” was negatively related to procrastination. In addition, two-step hierarchical regression analysis indicated that procrastination negatively predicted achievement in the first step. However, in the second step, only the “challenge-skills balance” dimension of flow positively predicted achievement. Implications for Research and Practice: In Calculus courses, if students are given tasks that foster their focus, their procrastination behavior can be diminished. In addition, if they are given tasks that are appropriate to their level and skills, their academic achievement can be predictably higher. In this context, real-life applications should relate to students’ own interests and skills. Therefore, their academic achievement can be higher.

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Introduction

When people are engaged in an activity that involves high concentration, high enjoyment, and losing track of time, they are said to be at the state of optimal experience, which is called flow (Csikszentmihalyi, 1975; 1997). In a flow state, individuals perceive themselves as successful regarding their performance, and this perception gives them pleasure. Individuals do the activity for its own sake, and there is no other further goal (Nakamura & Csikszentmihalyi, 2002). Csikszentmihalyi (1975) initially identified four elements related to flow state: control, attention, curiosity, and interest. These four elements were later elaborated, and nine elements of flow state were defined (Csikszentmihalyi, 1996): (1) There are clear goals for every step of the way (i.e. in flow, individuals know what should be done and in what order). (2) There is immediate feedback for one’s actions (i.e. in flow, individuals know how well they are doing and they are aware of their performance). (3) There is a balance between challenges and skills (i.e. individuals feel that their abilities are well matched to the opportunities for action). (4) Action and awareness are merged (i.e. in flow, individuals are aware of what is here and now). (5) Distractions are excluded from consciousness (i.e. in flow, individuals’ concentration is focused on what they are doing; they are not thinking about anything else). (6) There is no worry of failure (i.e. in flow, individuals are not afraid of what they are doing because they don’t have full control of their actions; the action is done automatically). (7) Self-consciousness disappears (i.e. in flow, individuals are too involved in what they are doing). (8) The sense of time becomes distorted (i.e. in flow, individuals forget time, and hours may pass by in what seem like a few minutes). (9) The activity becomes autotelic (i.e. in flow, everything that individuals do is worth doing for its own sake) (Csikszentmihalyi, 1996).

Flow has been found to be related to adaptive outcomes such as satisfaction with life, hedonic balance, and psychological well-being (Bassi, Steca, Monzani, Greco, & Delle Fave, 2014; Collins, Sarkisian, & Winner, 2009). Research has also demonstrated that flow experiences improve students’ academic satisfaction and achievement (Carli, Delle Fave, & Massimini, 1988; Heine, 1996; Joo, Joung, & Sim, 2011; Nakamura, 1988). For example, in a study with undergraduate students, Seo (2011) reported that flow is positively related to academic achievement. Mendelson (2007) also found a positive relationship between flow and exam scores, as indicated by both exam scores and GPA. Moreover, undergraduate students’ flow was found to have a direct effect on achievement in an Application of Computers course (Joo, Oh, & Kim, 2015). Additionally, considering the nine elements of flow state, Shernoff, Csikszentmihalyi, Shneider and Shernoff (2003) showed that when students (a) experience challenging tasks, (b) feel that their skills are balanced with the challenge, and (c) control their climate, they are highly engaged in the learning environment. Moreover, Kim and Seo (2013) found that action-awareness merging, autotelic experience, and transformation of time were significant positive predictors of achievement behaviors. The latter two studies revealed that relationships between flow and academic outcomes can differ across different dimensions of flow. Thus, it appears that research on flow should focus on its specific dimensions rather than
examining flow as a single construct. Accordingly, in the current study, students’ flow experiences were examined in terms of the dimensions. In addition, flow experiences were examined specifically for a Calculus course. Accordingly, the findings here can shed light on whether other findings in the relevant literature can be generalized across different domains, such as art, sport, and mathematics.

With regard to flow studies in mathematics education, Seifert, Radu, and Doyle (2009) reported that flow is a deep cognitive experience for mathematics students. Moreover, a combination of challenge, concentration, and competence is important for experiencing flow. Mathematics students mostly experience flow alone and in an environment over which they have control. However, they also may experience flow while the mathematics instructor is working on a problem and they are concentrated on the instructor’s explanations (Seifert et al., 2009). Additionally, according to Radu and Seifert (2011), flow experiences in mathematics include clear goals, challenge-skill balance, and intense concentration. In particular, engagement in mathematics requires a challenge-skill balance. Moreover, becoming engaged in solving math problems requires a clear goal of solving the problem, which furthermore assumes a certain degree of concentration. Overall, the aforementioned literature has suggested that among flow dimensions, the positive predictors of achievement behaviors are challenge-skill balance, clear goals, high control, and high concentration.

Apart from flow, several studies have been conducted regarding academic procrastination, which is one of the maladaptive behaviors of students. According to Lay (1986), procrastination is a failure to finish what has to be done to attain goals. In other words, when individuals continue to fail to do what they should be doing to attain certain desirable goals, then procrastination behavior occurs. Moreover, Solomon and Rothblum (1984) defined procrastination as “the act of needlessly delaying tasks past the point of discomfort” (p. 503). Accordingly, academic procrastination involves delaying study-related activities, such as studying for an examination or writing a term paper (Klingsieck, Grund, Schmid, & Fries, 2013). Procrastination has been related to maladaptive outcomes in high school students, such as anxiety and low self-esteem (Besinck, Rothblum, & Mann, 1986), low examination grades and poor academic achievement (Beck, Koons, & Milgrim, 2000; Popoola, 2005; Tice & Baummestier, 1997), and amotivation (Lee, 2005). However, Seo (2011) found that procrastination (with its dimensions) was not a significant predictor of achievement for university students. Regarding the reasons for student procrastination, these behaviors are caused by low self-efficacy (Ferrari & Emmons, 1995), perfectionism (Onwuegbuzie, 2000), fear of failure (Rothblum, 1990), unclear directions (Schraw, Wadkins, & Olafson, 2007), and lack of time management and inability to concentrate (Noran, 2007). However, situational interest (Corkin et al., 2014), intrinsic motivation (Desrosiers, 2016), effort regulation (Rakes & Dunn, 2010), and conscientiousness (Ozer, 2012) were negatively related to academic procrastination.

At this point, it is important to note that because study behaviors can change across domains, examination of procrastination in a specific domain—such as mathematics—can have high predictive value (Choi 2005). According to Asikhia
(2010), many students, especially those in mathematics courses, do not study hard until the examination period, because mathematics is a demanding subject in terms of mathematical reasoning and problem solving. Akinsola, Tella, and Tella (2007) showed that many students perceive mathematics as high-demanding and difficult, and procrastination often occurs when a task is perceived as difficult or unpleasant. Mathematics also involves cognition effects and does not seem easy to anyone (Sutton, 1997). Moreover, some students often dislike mathematics as a subject, since it is often related to pain and frustration, and thus many students procrastinate in studying mathematics (Asikhia, 2010; Hopper, 2005). Considering this available literature, in the present study, students’ procrastination and its relation with achievement were examined specifically for a Calculus course. The results have the potential to lead to specific implications for higher-education practices in Calculus courses.

Many researchers have also studied the relationship between flow and procrastination. In a study examining the relationship between students’ flow, motivation, and procrastination, Lee (2005) found that a negative relationship exists between university students’ flow and procrastination in an Educational Psychology course. In the study, the author included five dimensions of flow: clear goal, challenge-skill balance, concentration on the task, unambiguous feedback, and loss of self-consciousness. The author reported that in particular, college students’ concentration on the task, clear goals, and loss of self-consciousness negatively predicted their procrastination behavior. In actuality, according to Messmer (2001), avoiding procrastination is important to experience the flow state. Messmer (2001) suggested that challenges stemming from poor planning can be offset by setting priorities, time management, focusing all one’s attention on the immediate tasks and deadlines, and long-term goals. Moreover, Brinthaupt and Shin (2001) found that procrastination was positively related to action-awareness merging, challenge-skill balance, and unambiguous feedback, when considering all their current and recent courses.

Furthermore, Kim and Seo (2013) investigated the relationship between flow, self-regulation, active procrastination, and academic achievement in an Educational Psychology course. They found that challenge-skill balance was a significant positive predictor for active procrastination in both steps in the hierarchical regression analysis. According to Chu and Choi (2005), the relationship between procrastination and flow may vary depending on the type of procrastination. In fact, they found that active procrastinators (those who take volitional decisions to procrastinate and they finish their work before the deadlines) are better in flow than passive procrastinators (those who delay tasks until the last minute because they cannot manage their time effectively).

In this study, we will investigate the relationship between students’ flow experience and procrastination behavior in Calculus I course. Procrastination will be measured with the Academic Procrastination Scale, developed by Aitken (1982) and adapted to Turkish by Balkıs (2006). This scale includes items which may suggest passive procrastination (e.g. “I delay starting things so long, I don’t get them done by
the deadline”), and flow will be examined in 9 dimensions using the Flow State-2 Scale (Jackson & Eklund, 2004; Asci, Caglar, Eklund, Altintas, & Jackson, 2007), which was adapted to the Calculus course. When different findings from previous literature are considered, the expectation is that all nine dimensions of flow experiences will be negatively related to (passive) procrastination.

Considerable research has also examined relationships between procrastination and academic achievement in different contexts (Bruinsma & Jansen, 2009; Chu & Choi, 2015; Seo, 2011). In their meta-analysis, Kim and Seo (2015) concluded that academic performance and procrastination are negatively correlated. For example, Duru and Balkis (2014) found that academic procrastination in undergraduate students (from different departments in the faculty of education) negatively predicts their academic achievement. Moreover, passive procrastination negatively predicts undergraduate students’ Human Anatomy exam grades and course grades (Hensley, 2014). With regard to the relationship between flow, procrastination, and achievement, Kim and Seo (2013) examined the relationship between flow, self-regulation, active procrastination, and achievement. They found that challenge-skills balance positively predicts active procrastination. When students procrastinated in their studies, they increased the level of challenge (either intentionally or unintentionally). Thus, they postponed their studies in order to establish a balance between the challenges of a situation and their skills (Csikszentmihalyi, 1997). Even though there are students who delay their studies in order to increase the challenge, not all students defer their studies because of this. For example, passive procrastinators felt pessimistic, and stressed especially about their ability to achieve when a deadline gets closer (Ferrari, Parker, & Ware, 1992). However, active procrastinators delayed their work intentionally, enjoying the feeling of being challenged in the last minute. Therefore, challenge-skill balance might be a unique feature of active procrastination, different from passive procrastination (Kim & Seo, 2013). They also found that action-awareness merging, transformation of time, and autotelic experience positively predicted academic achievement.

Keeping the aforementioned literature in mind, the current study aimed to provide a comprehensive picture of the relationship between each dimension of flow, procrastination, and achievement in a Calculus course. More specifically, the purpose of this study is to examine the extent to which flow experience predicts (passive) procrastination behavior, and to what extent flow and procrastination predict students’ achievement. Based on the aforementioned studies, while a negative relationship is expected between (passive) procrastination and achievement, and negative relationships between passive procrastination and dimensions of flow, a positive relationship is expected between dimensions of flow and achievement.

Purpose and Significance of the Study

The purpose of this study was twofold: (1) to examine to what extent students’ flow experience (with its dimensions) predicts their academic procrastination in a Calculus I course, and (2) to explore to what extent students’ academic
procrastination and flow experience (with its dimensions) predict undergraduate students' achievement in a Calculus I course.

The present study aims to fill the gap in the literature in several ways. Firstly, even though some studies examine the relationship between students’ flow experience and procrastination in other domains (mostly Educational Psychology courses), flow has not been studied with its dimensions in examining both achievement and procrastination for Calculus (or mathematics). Thus, some clues can be obtained regarding how generalizable the findings in the relevant literature are concerning the proposed relations in different domains. If some differences are found, the findings can serve for more detailed practical implications for Calculus courses. Thus, this study has potential to make a contribution not only to educational psychology literature but also to mathematics education literature. In addition, the present study employed a different perspective than similar studies in the related literature (e.g. Brinthaupt & Shin, 2001; Seo, 2011). In these studies, researchers tried to determine whether procrastination is the reason for a flow state or not. They examined the relationship in terms of procrastinators’ experience of time pressure, which may result in a feeling of challenge for some students and a focus on one goal, which may in turn lead to a flow experience just before the deadline. They claim that procrastination can increase the flow state before a deadline. Since Chu and Choi (2005) claim that relationship between procrastination and flow may vary depending on the type of procrastination, it was hypothesized in the current study that if students experience flow state in their studies, they may not passively procrastinate in their academic studies, as Lee (2005) also found. Therefore, a negative relationship between flow and procrastination is expected in this study.

In addition, in this study, age was a covariate in the hierarchical regression analysis because some studies have found that age is significantly related with academic achievement in Calculus or mathematics achievement (Jarvis, 2000; Lunneborg & Lunneborg, 1966). Furthermore, the findings can have important implications for undergraduate programs in various departments, including engineering, mathematics, management, and statistics. In fact, the Calculus course is important for first-year students, and it is one of the high credit courses offered in the first year of academic programs. This course is important for all engineering, science, economics, mathematics, physics, and chemistry education students. After taking a calculus course, students are able to perform calculations and algebraic manipulations, specifically limits, differentiation, and integration. A student who is successful in this course gains several skills, such as applying differentiation in real-life situations.

The present study aimed to address following research questions:

1. To what extent do different dimensions of flow experiences predict students’ academic procrastination in a Calculus I course?
2. To what extent do different dimensions of flow and procrastination predict students’ academic achievement in a Calculus I course?
Method

Research Sample

Participants included 117 (54 males and 63 females) Turkish undergraduate students from 22 departments in 13 universities, who have taken the Calculus I course in their departments. They ranged in age from 19 to 40 years ($M_{age} = 23$, $SD = 3.36$). The participants were from the faculty of arts and sciences ($n = 47$), faculty of education ($n = 6$), faculty of engineering ($n = 55$) and faculty of economics and administration sciences ($n = 9$). The majority of the participants (42%) were seniors, and only 15% of them were freshmen. The percentages of sophomores and juniors were equal (21% each). More than half of the participants (60%) reported that they took Calculus I only once. The number of students who took the course twice was 22 (19.1%). The percentage of participants who took Calculus I three or four times were 8.7 and 4.3, respectively. Only 3.5% of participants reported that they took the course five times. Less than 1% of participants (0.8%) took Calculus I six or eight times. The percentage of the participants taking the course seven times was 2.6.

Research Instruments and Procedures

The data were gathered through an online survey, which was shared via social media. Before students completed the survey, they were informed about the purpose of the study and that their participation was voluntary and anonymous, and they could withdraw from the study at any time. The students read and signed a consent form. The data collection process was finished in two weeks in May 2017.

Flow. Undergraduate students’ perceived flow experience in the Calculus I course was measured by the 36-item Flow State-2 Scale (Jackson & Eklund, 2004). A validated Turkish version of the questionnaire (Asci, et al., 2007) was adapted to the Calculus I course. Students rated each item on a 5-point Likert scale (1-very wrong, 5-very true). The Flow State-2 Scale measures flow on nine dimensions: challenge-skill balance (4 items; e.g. “I was challenged, but I believed my skills would allow me to meet the challenge.”; $\alpha = .71$, when one item is excluded three-items $\alpha = .84$), merging of action and awareness (4 items; e.g. “Things just seemed to be happening automatically”; $\alpha = .83$), unambiguous feedback (4 items; e.g. “It was really clear to me how my performance was going.”; $\alpha = .90$), clear goals (4 items; e.g. “I knew clearly what I wanted to do”; $\alpha = .88$), concentration on the task at hand (4 items; e.g. “My attention was focused entirely on what I was doing”; $\alpha = .90$), sense of control (4 items; e.g. “I felt in total control of what I was doing in my Calculus course”; $\alpha = .90$) loss of self-consciousness (4 items; e.g. “I was not concerned with what others may have been thinking of me.”; $\alpha = .93$), transformation of time (4 items; e.g. “the way time passed seemed to be different from normal”; $\alpha = .77$, when one item is excluded three items $\alpha = .81$), and autotelic experience (4 items; e.g. “I really enjoyed the experience”; $\alpha = .85$). In the current study, a total of two items were excluded from challenge-skill balance and transformation of time subscales (1 item from each subscale) because removal of these items led to increases in the corresponding subscales. Moreover, due to high correlations of two dimensions (unambiguous feedback and sense of control) with other dimensions, leading to multicollinearity...
problems, these two dimensions were not included in the regression analyses. Therefore, out of 36 items, in total 10 flow items were excluded from this study. A CFA with the 26 items loading on 7 latent factors yielded the following fit: $S-B\chi^2(278, N=117) = 360.525$, $p < .01$, $CFI = .962$, $SRMR = .054$, $RMSEA = .050$ (90%-CI: .035 - .064).

Procrastination. Perceived academic procrastination in Calculus courses was measured by the 16-item Academic Procrastination Scale (Aitken, 1982). A validated Turkish version of the questionnaire (Balkıs, 2006) was adapted to Calculus course. Four items were excluded from the analysis (e.g. “I’m careful to return library books on time”) because they did not ask about course-related activities, such as studying or doing homework. Students rated each item on a 5-point Likert scale (1-very wrong, 5-very true). All twelve items measured students’ academic procrastination (12 items; e.g. “If I had an important project to do, I’d get started on it as quickly as possible”; $a = .92$, after 2 items were excluded, $a = .93$). The CFA conducted with the twelve items loading on one latent factor yielded the following fit indices: $S-B\chi^2(54, N=117) = 119.264$, $p < .01$, $CFI = .928$, $SRMR = .054$, $RMSEA = .102$ (90%-CI: .081 - .122). After considering modification indices, two items were excluded from the analysis because of low-fit indices. The second CFA was conducted using the remaining ten items and provided a good model fit: $S-B\chi^2(35, N=117) = 58.646$, $p < .01$, $CFI = .969$, $SRMR = .044$, $RMSEA = .076$ (90%-CI: .045 - .104).

Academic achievement. Students’ academic achievement in their Calculus courses was measured by their grades (0 to 100) at the end of their courses (Mgrade = 68.74, SD = 19.61).

Data Analysis

In the current study, a multiple regression analysis was conducted in order to investigate academic procrastination in relation to dimension of flow experiences in the Calculus I course. Additionally, a two-step hierarchical regression analysis was carried out in order to examine students’ achievement in the Calculus I course in relation to dimensions of flow and academic procrastination.

Results

Preliminary Analyses

Assumptions of regression analyses were checked in preliminary analyses, and means, standard deviations, and bivariate correlations among the variables were examined. Accordingly, multicollinearity, outliers, normality, linearity, homoscedasticity, and independence of residuals assumptions were checked prior to regression analyses. With regard to the multicollinearity assumption, all the bivariate correlation coefficients below 0.8 suggested that there was no violation of the multicollinearity assumption. In order to determine potential outliers, Mahalanobis distances were inspected. Absence of cases with Mahalanobis distances exceeding the critical value indicated that there were no potential outliers. Indeed, all Cook’s
distances were less than 1, so there were no cases which substantially influenced the regression equation. Then, linearity, homoscedasticity, and independence of residuals assumptions were checked by examining the standardized residuals to a standardized predicted plot, and it was found that all the assumptions were met (Pallant, 2005; Tabachnick & Fidell, 2001).

After checking the underlying assumptions, descriptive statistics and bivariate correlations were calculated (see Table 1). With regard to the dimensions of flow experience, the mean scores indicated that the highest mean score belonged to the ‘loss of self-consciousness’ sub-scale (M = 3.49). On the other hand, the lowest mean score belonged to the ‘concentration on the task at hand’ sub-scale (M = 2.6). Thus, it appeared that, compared to other flow dimensions, participants tend to have lower levels of flow experience regarding concentration on the tasks in Calculus courses, but higher levels of flow experience regarding loss of self-consciousness while involved in a task. In general, the mean scores around 3 suggested that participants had a moderate level of flow experience in almost all dimensions. With regard to procrastination, the mean score of 3.52 showed that participants’ procrastination levels in Calculus course were not low. In addition, their mean achievement score appeared to be at a moderate level (M = 68.74). Concerning the bivariate correlations, results indicated that age was positively related to achievement (r = .21, p < .05), and procrastination was negatively related to achievement (r = -.39, p < .01). In addition, procrastination was negatively and significantly correlated with all the dimensions of flow except loss of self-consciousness.

Table 1
Means, Standard Deviations, and Bivariate Correlations of the Measured Variables

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<td>4. Cgoal</td>
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<td>5. Focus</td>
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<td>6. Loss</td>
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<td>7. Time</td>
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<td>.39**</td>
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<td>-.53**</td>
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<td>1.04</td>
<td>1.09</td>
<td>1.20</td>
<td>1.10</td>
<td>1.13</td>
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Note. *p < .05, **p < .01; 2=Challenge-skill balance, 3=Merging of action and awareness, 4=Clear goals, 5=Concentration on the task at hand, 6=Loss of self-consciousness, 7=Transformation of time, 8=Autotelic experience, 9=Procrastination, 10=Achievement
Inferential Statistics

Multiple regression analysis. A multiple regression analysis was used to examine the students’ academic procrastination in relation to their flow experiences in the Calculus I course. Procrastination was regressed on the dimensions of flow and the model was significant: \((F(7, 109) = 16.50, p < .01, R^2 = .51)\). As can be noticed in Table 2, concentration on the task at hand was found to be negatively associated with procrastination in the Calculus I course \((\beta = -.70, p < .01)\). However, all the other dimensions were not significantly associated with student procrastination. It seems that when students have high concentration on the tasks, they have less tendency to procrastinate their studies in the Calculus course. In other words, when students cannot concentrate on the tasks, then they tend to procrastinate more.

<table>
<thead>
<tr>
<th>Predictors</th>
<th>(B)</th>
<th>(SE)</th>
<th>(\beta)</th>
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<td>1. Chall</td>
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<td>.12</td>
<td>-.05</td>
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<td>3. Cgoal</td>
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<td>.11</td>
<td>-.03</td>
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<td>4. Focus</td>
<td>-.63</td>
<td>.12</td>
<td>-.70**</td>
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<tr>
<td>5. Loss</td>
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<td>.06</td>
<td>.02</td>
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<td>6. Time</td>
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</tr>
<tr>
<td>7. Auto</td>
<td>-.18</td>
<td>.12</td>
<td>-.21</td>
</tr>
<tr>
<td>(F) change (7, 109)</td>
<td>16.50</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. \(*p < .05, **p < .01; 1=Challenge-skill balance, 2=Merging of action and awareness, 3=Clear goals, 4=Concentration on the task at hand, 5=Loss of self-consciousness, 6=Transformation of time, 7=Autotelic experience.\)

Hierarchical regression analysis. A hierarchical regression analysis was used to explore undergraduate students’ academic achievement in the Calculus I course in relation to their procrastination and flow experiences. Achievement was regressed on age and procrastination in Step 1 and flow dimensions in Step 2. The models in Step 1 and 2 were significant: \((F(2, 114) = 12.84, p < .01, R^2 = .18)\) and \((F(7, 107) = 3.74, p < .01, R^2 = .34)\) respectively. As can it be noticed in Table 3, age was found to be positively associated with students’ achievement in the Calculus I course \((\beta = .17, p < .05)\), while the relationship between procrastination and Calculus achievement was negative \((\beta = -.37, p < .01)\). The results also showed in the second step of the analysis that, when flow dimensions are included in the model, procrastination does not significantly predict course achievement above and beyond all the other flow dimensions. However, the link between challenge-skill balance and Calculus achievement was found to be positive \((\beta = .30, p < .05)\). This finding implies that when students feel that their abilities are well matched to their opportunities for action, they have higher levels of achievement.
### Table 3

Hierarchical Two-Step Regression Analysis for Academic Achievement in Calculus Course

<table>
<thead>
<tr>
<th>Predictors</th>
<th>Achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Step 1</td>
</tr>
<tr>
<td></td>
<td>(B)</td>
</tr>
<tr>
<td>1. Age</td>
<td>1.00</td>
</tr>
<tr>
<td>2. Procr</td>
<td>-7.34</td>
</tr>
<tr>
<td>3. Chall</td>
<td>5.58</td>
</tr>
<tr>
<td>4. Act</td>
<td>.63</td>
</tr>
<tr>
<td>5. Cgoal</td>
<td>3.13</td>
</tr>
<tr>
<td>6. Focus</td>
<td>-1.57</td>
</tr>
<tr>
<td>7. Loss</td>
<td>-3.05</td>
</tr>
<tr>
<td>8. Time</td>
<td>.58</td>
</tr>
</tbody>
</table>

\(F\) change (7, 107) 12.84 3.74

Note. *\(p < .05\), **\(p < .01\); 2=Procrastination, 3=Challenge-skill balance, 4=Merging of action and awareness, 5=Clear goals, 6=Concentration on the task at hand, 7=Loss of self-consciousness, 8=Transformation of time, 9=Autotelic experience.

### Discussion and Conclusion

This study first explored undergraduate students’ academic procrastination in relation to their flow experiences in a Calculus I course. Multiple regression analysis results showed that among flow experience dimensions, only students’ concentration on the task at hand (focus) is negatively related to their procrastination. Therefore, as found in relevant literature (Lee, 2005), focus appears to be an important factor to consider to diminish students’ procrastination behavior. In addition, hierarchical regression analysis showed that in Step 1, age and procrastination were significantly linked to achievement. While age was found to be positively related to achievement, procrastination was negatively related to achievement, consistent with related literature (Jarvis, 2000; Kim & Seo, 2015; Lunneborg & Lunneborg, 1966; Seo, 2011).

Hierarchical regression analysis also showed that in Step 2, when flow dimensions are included in the model, procrastination does not significantly predict course achievement above and beyond all the other flow dimensions. In Step 2, the balance between challenges and skills (i.e. individuals feel that their abilities are well matched to the opportunities for action) emerged as a powerful predictor of students’ performance in Calculus. These findings suggest if they are provided with challenging activities that match well with their skills, their academic performance in Calculus appears to be better. On the other hand, results also showed that the relationships between remaining dimensions of flow and Calculus achievement were not significant. One of the reasons could be the small sample size, with students coming from various departments. Another reason could be that in Calculus courses, the most important factor seems to be the difficulties of the tasks. Therefore, students may not experience the other dimensions of flow (merging of action and awareness, having clear goals, concentrating on the task at hand, losing self-consciousness, feeling transformation of time, and feeling autotelic experience) if they don’t have the
balance between their skills and the challenge of the tasks. In other words, if they
don’t see that their skills and the task challenge are balanced (i.e. the tasks may be
much more difficult than the students’ skills, or the tasks may be much easier than
the students’ skills), students may not experience the other dimensions. Indeed,
according to Csikszentmihalyi (1975, 2000), flow experience requires a balance
between challenge and skills. Fong, Zaleski, and Leach (2015) also state that “Flow is
an intrinsically motivating state of consciousness characterized by simultaneous
perception of high challenge and skill” (p. 425). The challenge-skill balance as a
primary antecedent of flow experience is not clear, and more research is necessary
to clarify the effect of challenge-skills balance on flow in multiple fields (Fong et al.,
2015). Thus, it is suggested that future research can examine in detail the
relationships between students’ flow experiences and the reasons of procrastination
behaviors, integrating qualitative research designs. For example, in depth-interviews
could be conducted with students.

Overall, the present study showed that students’ concentration was negatively
and significantly related to their procrastination behavior. This study has contributed
to the relevant literature in demonstrating that among the dimensions of flow,
concentration is a crucial element against procrastination in Calculus. When students
don’t concentrate on their Calculus studies, they may procrastinate their studying. In
addition, this study was the first step in learning about what the most important
dimension is—from the students’ perspectives—to prevent procrastination behavior
in students’ Calculus studies. This study also showed that students’ procrastination
behavior is negatively and significantly related to students’ performance in Calculus
classes, leading to lower levels of achievement. This finding was in line with the
relevant literature. Indeed, Kim and Seo (2015) found a similar result. In addition, in
the current study, the balance between challenges and skills is found to be
significantly related to the students’ performance in Calculus classes, leading to
higher levels of achievement; this provides a support for the available literature
(Mendelson, 2007; Seo, 2011).

One of the strongest points of this study that sets it apart from previous research
is that this study focused on a Calculus course and involved students from different
departments, including engineering, business administration, economy, statistics,
mathematics, and science and mathematics education. For these departments, a
Calculus course is mandatory, and students must pass this course in order to
continue their studies. Due to this importance of this course, it is worth taking a
closer look and studying the relationship between flow, procrastination, and
achievement in Calculus, in order to be able to make specific suggestions to improve
students’ achievement behaviors.

Accordingly, based on the current findings and the available literature, it is
suggested that students are provided with tasks in Calculus courses that are
conducive to their flow experience. In order to help students experience flow, the
tasks should be interesting, challenging, and matched to students’ abilities. In
addition, the classroom environment should be free from stress, anxiety, and other
negative emotions (Csikszentmihalyi, 2000; Schmidt, 2010). Considerable research
also demonstrated that intrinsic motivation is related to flow experience (Choe, Kang, Soe, & Yang, 2015; Pintrich & Schunk, 2002). Therefore, in order to enhance students’ flow experience—particularly fostering a balance between challenge and skills—instructors offering Calculus courses can create learning environments that are conducive to students’ intrinsic motivation, satisfying their basic psychological needs of autonomy, competence, and relatedness (Deci & Ryan, 2000; 2002).

Accordingly, instructors can design a variety of interesting and challenging tasks and activities, among which students can choose. This can help students feel autonomous in their learning and experience more enjoyment. In addition, students can be expected to work in groups while dealing with activities, satisfying their need for relatedness. Moreover, especially to foster balance between challenge and skills, instructors should challenge students according to their abilities, by preparing some step-by-step tasks for students to achieve from easier to harder. Then, instructors should provide immediate feedback on students’ performance and prepare the tasks in line with their capabilities, contributing to the satisfaction of their competence needs. For example, while instructing about differentiation, an instructor in mechanical engineering can provide students with velocity and acceleration. By requiring these students to calculate vehicles’ velocity, it could further improve students’ understanding of Calculus in daily life applications. Therefore, their skills and challenge can be balanced, and they can be interested in what they are doing and thus can be more creative.

In this aspect, STEM-related activities in Calculus courses also brings about a balance between challenge and skills. Hartzler (2000) found that integrated curricula were successful in teaching mathematics and science across all grade levels. Especially if engineering students learn Calculus and its applications in their own field, then they can be more successful and creative in their fields in their future career. Additionally, web-based or computer-based instruction can be implemented in Calculus courses. Indeed, Heo and Rha (2003) demonstrated that the different facets of web-based instruction including interactivity, navigation, and content are associated with flow. Lee, Han, Kim, and Lee (2007) also reported that students in learning environments with e-learning systems are more likely to experience flow.

Limitations and Recommendations

There are some limitations of this study. Firstly, this is a cross-sectional study; thus, results do not imply any causation. In future research, longitudinal studies (since age is also an important factor for Calculus achievement) can be conducted to reveal cause-and-effect relations, and to investigate how these relationships change over time.

Secondly, data were collected through an online survey and the participants were from different departments, including engineering, management, mathematics, and education. Therefore, studies focusing on certain domains, such as engineering, can provide stronger and more explicit implications. If students from different departments and universities are included in future studies, hierarchical linear modelling (HLM)—a type of regression analysis appropriate for multilevel data—
should be used to analyze the data (Raudenbush & Bryk, 2002). Such multilevel analysis methods also allow for examining cross-level interactions among the variables (Raudenbush & Bryk, 2002).

Thirdly, the sample size in the current study was not large. In fact, the number of students from different departments was not sufficient to conduct HLM. In future studies, researchers can work with larger samples, using HLM and also demonstrating the generalizability of the findings.

Fourthly, in the present study, not all students were administered the online survey right after completing the Calculus course. As a result, some students may have experienced difficulty while responding to the survey items in reflecting their actual experiences in Calculus course, depending on the time span between data collection and course completion. Thus, in future studies, researchers are advised to administer surveys to students immediately after they complete the Calculus course.

In addition, future research can focus more on the reasons for procrastination in studying Calculus, and how students can experience flow, especially the balance between challenge and skills, in Calculus and mathematics in general. There is a need for interviewing students and finding out in which situations students have flow (or not) in their Calculus studies.

Finally, high correlations of two dimensions of flow experience (unambiguous feedback and sense of control) with other dimensions, lead to multicollinearity problems. Hence, these two dimensions were not included in the regression analyses. Therefore, flow could not be examined with all its dimensions, and future research could address this gap.

References


Ogretmen adaylarının davranislarında erteleme eğiliminin, düşünme ve karar verme tarzları ile iliskilerinin incelenmesi. [The relationships between student teachers’ procrastination behaviors, and decision-making styles] Yayınlanmamış Doktora Tezi. Dokuz Eylül Üniversitesi Egitim Bilimleri Enstitüsü, İzmir.


birleşimi, belirlenmiş hedefler, görevde odaklanma, kendilik farklılığının azalması, zamanın dönüşümü, amaca ulaşma deneyimi) ilişkilendirilerek incelenmesi amaçlanmıştır. İkinci olarak, lisans öğrencilerinin Analiz I dersindeki akademik başarısının, akademik erteleme davranışı ve akış deneyiminin alt boyutlarıyla ilişkilendirilerek incelenmesi hedeflenmiştir. Bu amaçlar doğrultusunda, bu çalışmada aşağıdaki sorulara cevap aranacaktır:

1. Analiz I dersi öğrencileri için akış deneyiminin alt boyutları akademik erteleme davranışı ne derece yordamaktadır?
2. Akış deneyimi ve akademik erteleme davranışı ne derece ne derecede Analiz I dersi başarısını yordamaktadır?


Araştırma Bulguları: İkili korelasyon sonuçları, yaşın başarıyla pozitif ilişkili olduğunu ($r = .21, p < .05$), ve akademik erteleme davranışın başına ne olacağını ($r = -.39, p < .01$) göstermiştir. Ayrıca, akademik erteleme davranışı kendilik farklılığının azalması alt boyutu harici akış deneyiminin bütün alt boyutlarıyla pozitif ilişkili olduğunu göstermiştir. Çoklu regresyon analizinde, akademik erteleme davranış ile akış deneyimin alt boyutları bağımsız değişken alnarak regresyon modeli oluşturulmuştur ve model analamlı bulunmuştur: $(F (7, 109) = 16.50, p < .01, R^2 = .51)$. Çoklu regresyon analizi, akış davranışının alt boyutlarından olan, odaklanma’nın, akademik erteleme davranışı negatif yöndedirğini göstermiştir ($β = -.70, p < .01$). Ayrıca, iki aşamalı hiyerarşik regresyon analizi, ilk aşamada $(F (2, 114) = 12.84, p < .01, R^2 = .18)$ akademik erteleme davranışın analiz dersindeki akademik başarıyı ne olacağını pozitif şekilde yordadığı ($β = -.37, p < .01$), ikinci aşamada $(F (7, 107) = 3.74, p < .01, R^2 = .34)$ ise akademik erteleme davranışın akademik başarıyı yordadığı ve sadece akış deneyiminin alt boyutlarından olan görev-zorluğu-beceri dengesi’nin Analiz dersindeki akademik başarı pozitif şekilde yordadığı ($β = .30, p < .05$) göstermiştir.

Araştırma Sonuçları ve Önerileri: Bu çalışmada ilk olarak lisans öğrencilerinin Analiz dersindeki akademik erteleme davranışı ve akış deneyiminin alt boyutları

Anahtar Sözcükler: Akış, erteleme davranış, başarı, Analiz dersi.