ATTENDANCE AND SOCIAL INTERDEPENDENCE IN GAME DEVELOPMENT LABS

by

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ABSTRACT

This is an exploratory research study aimed toward steadying attendance across a semester of higher education video game development labs with attention to cooperation as a co-factor. Following the observation of unusually strong attendance in a highly cooperative game development lab class which aligns with these theories, this paper seeks to explore whether subfactors of positive social interdependence are co-factors with lab attendance. Sparked by previous case data, this exploratory study examines data from the Fall 2019 iteration of the introductory video game development course, defining and measuring potential co-factor variables during an individual-focused half of the course supplemented with group activity, and a fully group-focused half of the semester, with future interest in investigating a correlation between attendance and positive interdependence. Empirical studies of both the performance impact of attendance, and the financial reliance of residential higher education institutions on student attendance and retention suggest that understanding how to operationalize students' motivation to attend class is epistemically and fiscally valuable. Studies of positive interdependence raise interest as a co-factor contextually through high commitment, joint efficacy, and mutual benefit, strongly overlapping with empirical antecedents of higher education retention and seminal social psychological frameworks. Therefore, the author began an intended extensive analysis of consecutive semesters. All students enrolled in the Fall 2019 introductory game development course (n=56 for students with matched data sets, 59 retained participant students total) were engaged in cooperatively-designed lectures and lab activities, with the first half of the semester's lighter collaborative activity and independent assigned work to be compared to the second half's full-time group project work. Between these designed halves, two null hypotheses were assessed: 1) lab attendance in the first half of the semester is

equivalent to the second half, and 2) subfactors of positive interdependence in the first half of the semester are equivalent to the second half. Attendance proportions and surveyed positive interdependence measures for the Fall 2019 semester were analyzed using paired sample t-tests. Attendance, and a majority of positive interdependence subfactors were not significantly different across halves of the semester, suggesting that collaboration had evened results across the whole, but not all effects reached their target results. The Classroom Life Instrument was used to formally measure the presence of a positive interdependent context before and after group project work.

INTRODUCTION

> Physically individuals are discrete; functionally they are members of groups; but they can be the latter only when the group is part of their view… Group goals must be held and cherished by individuals; the aims and needs of individuals are the only valid goals of groups… From this it becomes understandable that a group can feel responsible for the individual and that the individual can feel responsible for his group. (Asch, 1952, pp. 257–258)

During the Fall 2017 semester of the Purdue Polytechnic Institute's introductory video game development course, a course design emphasizing collaboration among students was employed; an extremely collaborative atmosphere and an unusually high and consistent lab attendance rate was then observed (Erdei, McCord, & Whittinghill, 2019). The following year (Fall 2018), the design of this Purdue game development course was altered to emphasize a more individualized curriculum; decreased attendance was then observed until end-of-semester groupwork began. According to studies of student retention and attendance in higher education, social integration of students is pivotal in their ability to persist to graduation (Braxton et al., 2013). The theory of social interdependence (Johnson & Johnson, 2003) furthermore elaborates that inclusive, cooperative work leads to high commitment from students. Following the observation of unusually consistent attendance counts in a highly cooperative Purdue Polytechnic Institute game development lab class (Erdei, McCord, & Whittinghill, 2019) which aligns with these theories, this paper seeks to explore whether subfactors of positive social interdependence are an effective co-factor with lab attendance.

Problem

Attendance in game development education enables a face-to-face group-based learning context analogous to an industry performance context. Group work has appeared to be effective in creating accountability and surprisingly high attendance rates in the Purdue Polytechnic Institute's game development coursework. However, introductory individual-focused activities do not appear to yield the high attendance rates of group activities; the variable co-factors that cultivate unusually high attendance in group-based lab activities are not well defined enough to operationalize in individual-focused labs. This study addresses this gap by analyzing the difference between attendance rates and measurements of cooperation in individual-focused and group-focused halves of a collaboratively designed semester of the Purdue Polytechnic's introductory game development class.

Purpose

The purpose of this project is to investigate the equivalence of attendance and positive interdependence subfactors in two collaborative activity treatments in a Purdue Polytechnic Institute introductory video game development course, as well as the effect of positive interdependence subfactors as a potential co-factor variable to lab attendance. The research questions and hypotheses posed were:

- RQ1) Is lab attendance proportionally equivalent between the first half and second half of the semester?
    - $H0_1$: Lab attendance in the first half of the semester is equivalent to the second half.
      HA_1: Lab attendance in the first half of the semester is not equivalent to the second half.
- RQ2) Is positive interdependence equivalent between the first half and second half of the semester?
    - $H0_{2A}$: Cooperative learning in the first half of the semester is equivalent to the second half.

HA_{2A}: Cooperative learning in the first half of the semester is not equivalent to the second half.

- $H0_{2B}$: Positive goal interdependence in the first half of the semester is equivalent to the second half.
  HA_{2B}: Positive goal interdependence in the first half of the semester is not equivalent to the second half.
- $H0_{2C}$: Resource interdependence in the first half of the semester is equivalent to the second half.
  HA_{2C}: Resource interdependence in the first half of the semester is not equivalent to the second half.
- $H0_{2D}$: Instructor academic support in the first half of the semester is equivalent to the second half.
  HA_{2D}: Instructor personal support in the first half of the semester is not equivalent to the second half.
- $H0_{2E}$: Student personal support in the first half of the semester is equivalent to the second half.
  HA_{2E}: Student academic support in the first half of the semester is not equivalent to the second half.
- $H0_{2F}$: Student academic support in the first half of the semester is equivalent to the second half.
  HA_{2F}: Student academic support in the first half of the semester is not equivalent to the second half.
- $H0_{2G}$: Student personal support in the first half of the semester is equivalent to the second half.
  HA_{2G}: Student personal support in the first half of the semester is not equivalent to the second half.
- $H0_{2H}$: Class cohesion in the first half of the semester is equivalent to the second half.
  HA_{2H}: Class cohesion in the first half of the semester is not equivalent to the second half.
- $H0_{2I}$: Fairness of grading in the first half of the semester is equivalent to the second half.
  HA_{2I}: Fairness of grading in the first half of the semester is not equivalent to the second half.
- $H0_{2J}$: Achieving for social approval in the first half of the semester is equivalent to the second half.
  HA_{2J}: Achieving for social approval in the first half of the semester is not equivalent to the second half.
- $H0_{2K}$: Academic self-esteem in the first half of the semester is equivalent to the second half.
  HA_{2K}: Academic self-esteem in the first half of the semester is not equivalent to the second half.
- $H0_{2L}$: Alienation in the first half of the semester is equivalent to the second half.
  HA_{2L}: Alienation in the first half of the semester is not equivalent to the second half.

- RQ3) Is positive interdependence associated with lab attendance?

- $H0_{3A}$: Cooperative learning is not proportionally related with lab attendance.
  HA_{3A}: Cooperative learning is proportionally related with lab attendance.
- $H0_{3B}$: Positive goal interdependence is not proportionally related with lab attendance.
  HA_{3B}: Positive goal interdependence is proportionally related with lab attendance.
- $H0_{3C}$: Resource interdependence is not proportionally related with lab attendance.
  HA_{3C}: Resource interdependence is proportionally related with lab attendance.
- $H0_{3D}$: Instructor academic support is not proportionally related with lab attendance.
  HA_{3D}: Instructor academic support is proportionally related with lab attendance.
- $H0_{3E}$: Instructor personal support is not proportionally related with lab attendance.
  HA_{3E}: Instructor personal support is proportionally related with lab attendance.
- $H0_{3F}$: Student academic support is not proportionally related with lab attendance.
  HA_{3F}: Student academic support is proportionally related with lab attendance.
- $H0_{3G}$: Student personal support is not proportionally related with lab attendance.
  HA_{3G}: Student personal support is proportionally related with lab attendance.
- $H0_{3H}$: Class cohesion is not proportionally related with lab attendance.
  HA_{3H}: Class cohesion is proportionally related with lab attendance.
- $H0_{3I}$: Fairness of grading is not proportionally related with lab attendance.
  HA_{3I}: Fairness of grading is proportionally related with lab attendance.
- $H0_{3J}$: Achieving for social approval is not proportionally related with lab attendance.
  HA_{3J}: Achieving for social approval is proportionally related with lab attendance.
- $H0_{3K}$: Academic self-esteem is not proportionally related with lab attendance.
  HA_{3K}: Academic self-esteem is proportionally related with lab attendance.
- $H0_{3L}$: Alienation is not proportionally related with lab attendance.
  HA_{3L}: Alienation is proportionally related with lab attendance.

Significance of the Problem & Purpose

It is not uncommon for researchers to explore the factors and rationale behind absenteeism in higher education (Kottasz, 2005; Paisey & Paisey, 2004), but should research be believed that absentee behavior may be due to rational decision-making, the gap in research on the inverse—the drive to attend—appears more clearly. Kottasz outlined that a student's decision to attend schooling is dependent on both the ability and the motivation to attend, and in the case of the latter, additional research is sought after (2005).

In a study of student attendance and absenteeism and their relation to performance, educational researchers discovered that students' elaborations for missing class trended toward

similar, rational reasons (Lukkarinen, Koivukangas, & Seppälä, 2016); one report described "Students appeared to have a realistic view of their attendance" (Paisey & Paisey, 2004, p. 45). Overlapping class schedules and part-time jobs would keep learners from the classroom environment and their fellow classmates; fortunately, independent minds could afford to miss class and still perform well on exams (Lukkarinen, Koivukangas, & Seppälä, 2016). However, in courses built for team-based careers in which solitary work is rarely an option, every day of attendance counts to gain experience in an appropriate, needs-based performance context with peers (Dick, Carey, & Carey, 2014).

As students in higher education video game development will form interdisciplinary teams for major projects, analogous (albeit at a much smaller scale) to those in industry careers (Reimer, 2005), and with only up to eight lab sessions may occur before these teams form, this time allows students to familiarize with each other and form productive subcultural bonds. Crucially, moments of synchronous, constructive interaction while scaffolding legitimate game development skills are what transform the learning context closer to the performance context, something not easy to do without the computers and time allotted of labs (compared to lectures) (Driscoll, 2005; Triplett, 2017).

Social psychological foundations (Asch, 1952; Wenger, 1998), in-situ epistemological theory (Lave & Wenger, 1991; Wenger-Trayner, 2011), interactionalist theory (Braxton et al., 2013; Tinto, 1975, 1986, 1993), as well as insights into the impact of motivation (Kottasz, 2005) and social belonging (Osterman, 2000) have paved a groundwork for the viability of positive social interdependence (Johnson & Johnson, 2003) as a co-factor of student commitment and retention in their holistic group of classroom learners. Yet, a gap in literature exists in the impact of social interdependence's effect on collaborative career focused domains of education, and

much research on higher education attendance faces substantial limitations (Paisey & Paisey, 2004) or elects to seek understanding beneath attendance behaviors (Kottasz, 2005). Launching from historic attendance trends studied in a video game development lab class (Erdei, McCord, & Whittinghill, 2019), with institutional motivations to seize improvements in the Purdue Polytechnic Institute's video game development labs, this project sets out to explore the effect of positive interdependence on student attendance in higher education and prepare for expanded research.

Key Variables & Definitions

CGT Game Dev I—(operational) Computer Graphics Technology major course at Purdue Polytechnic Institute, introductory video game development.

F2017, F2018, F2019—(operational) refers to the Fall semester and year for one select course of the Purdue Polytechnic Institute's CGT Game Dev I course: *F2017* denotes *CGT Game Dev I Fall 2017*.

attendance—(operational) a student is present in class, with no distinction for being late or not.

late, late arrival—(operational) a student is present to class, but only after activity has begun, with no distinction of how late they have arrived.

lab section—(operational) the day and time of the week that a student regularly meets for lab, e.g. lab sections for Fall 2019 are Monday from 9:30 AM – 11:20 AM, Tuesday from 7:30 AM – 9:20 AM, and Thursday from 9:30 AM – 11:20 AM.

lab session—(operational) the lab contained lesson and/or activities given once for each lab section in the span of a week; a Monday lab session is identical to the Tuesday lab

session in the same week; with 16 total work weeks in an academic semester, there are 16 unique lab sessions.

Co-Opportunities, Co-Ops—(operational) 5 to 15-minute-long lab activities in which pairs or small groups of students work together to answer open-ended questions about the lab session's game development topics and generate small ideas for their projects.

motivation—defined as "the degree to which individuals commit effort to achieve goals that they perceive as being meaningful and worthwhile" and understood to be emotionally driven and from a social source (Johnson & Johnson, 2003, p. 137).

social integration—a theory describing the social affiliation and congruence of a student at the institutional and subcultural level, distinguishing six constructed antecedents of student persistence and retention (Braxton et al., 2013).

social interdependence—a motivational framework being investigated as a co-factor to attendance, describing the phenomenon of an individual's outcomes being contingent on others' actions; it includes distinctions of cooperative, competitive, and individualistic contexts (Johnson & Johnson, 2003, p. 142).

cooperation—a social interdependent context qualified by observed "mutual benefit, joint efficacy, intrinsic motivation, epistemic curiosity aroused by opposing views, [and] high commitment" (Johnson & Johnson, 2003, p. 142).

competition—a social interdependent context qualified by observed "differential benefit, differential efficacy, extrinsic motivation, [and] defensive adherence aroused by opposing views" (Johnson & Johnson, 2003, p. 142).

long-term retention—refers to a student persisting in an educational system up to successful graduation; the prevention of student departure or drop-out (Braxton et al., 2013).

Delimitations

The influence of gender identity and student demographic were not included in this study due to scope and sample limitations.

Although self-report survey data has been collected regarding the reasons and motivations for students' attendance, no statistical analysis is performed on these data within the scope of this study. Some survey questions meant for scoring positive interdependence likely introduce data regarding students' attendance and social motivations, though observations regarding students' legitimate reasons for missing (Kottasz, 2005; Paisey & Paisey, 2004) suggest that the understanding of students' motivations behind attendance cannot be fully addressed.

No investigation or statistical analysis of the direct benefits of attendance is performed in this study.

Assumptions

It is assumed that the length of time taken before a student responded to a weekly survey did not significantly impact the quality or integrity of their responses, and that students who missed one or more weekly surveys did not disrupt the representative quality of the weekly survey's sampling.

Limitations

As an exploratory study of data with no control group, generalizability is limited. The short range of data, lack of controlled condition, inability to pretest, and vast array of undiscussed factors could have influenced attendance in the students' environments.

In particular, the nature of RQ3's limited effect size and potential for variance in attendance data per each distinct half of a sixteen week semester (with some weeks excused for mandated breaks) may produce results that are simply not meaningful to apply in practice, even with statistical correlation achieved between positive interdependence and attendance.

The Classroom Life Instrument (Johnson, Johnson, & Anderson, 1983) used in this study may be vulnerable to confounded comprehension and answers due to descriptions of classroom activities and the value judgments students make of them, as the instrument was initially tested on young students between 4^{th} – 9^{th} grade (Abrami & Chambers, 1994). However, notes from one of the instrument creators note for a similar social interdependence instrument that the survey's items were more cohesive for older respondents (Johnson & Norem-Hebeisen, 1979), reducing concern for this limitation. Minor adjustments have been made to wording in the instrument to best match the CGT Game Dev I context for F2019 students: "instructors" replaces "teacher; "assigned work" replaces "assignment"; "work" replaces "schoolwork"; "they" replaces "he/she" accordingly; "parents/guardians" replaces "parents." Two questions have also been removed, as they do not apply to grading in the course. An additional note precedes the survey stating that "group" should holistically reference the group work and partner activities performed throughout CGT Game Dev I. Although measures in this 1983 iteration of the instrument were internally validated at the time of its use, its scales may be out of date; given the opportunity, updated validation procedures will take place following the F2019 semester. Reviewers of the advisory committee found these minor adjustments in language to be suitable for testing. Furthermore, subscale factors of interest within the Classroom Life Instrument are not widely or substantially standardized, and therefore face skepticism as to their individual impact when analyzed and discussed.

BACKGROUND

CGT Game Dev I historical data results

Drs. Ron Erdei and David Whittinghill and teaching assistant and co-instructor Brantly McCord investigated a case of unusual historical data in the Purdue Polytechnic Institute's CGT Game Dev I course, Fall 2017 (2019). This case serves as the cornerstone of interest for this study.

In Fall 2017 (F2017), CGT Game Dev I sustained unexpectedly steady, high attendance rates from end to end of the course with rare absences, with approximately 60% of class sessions having only one or no students absent (see Figure 1) (Erdei, McCord, & Whittinghill, 2019). With two two-hour labs a week and 40 students in a room with and only 23 built-in computer workstations, much in-class work was done in randomly sorted partners. Informal group exercises practicing the day's learning traditionally occurred at least once a week, and formal group projects taking place in the final six weeks of the course, the instructor and co-instructing teaching assistant observed a socially boisterous classroom. During activities, students would reach out to prior partners who had been given to them randomly in order to ask questions alongside a new partner, and while the teaching assistant kept busy troubleshooting with individuals, groups would elect to help each other, calling out across the room and generally being talkative through their work (Erdei, McCord, & Whittinghill, 2019).

The following year, Fall 2018 (F2018), condensed sophomores and juniors into the same student body for CGT Game Dev I, increasing enrollment from 40 to 91 students; to compensate, the curriculum was changed to hold two one-hour lectures and six small sections of a two-hour lab each week, with 20 students or less in each lab section. In compensating for lost lab time, early informal group activities during the first half of the semester's labs were cut in favor of

more traditional walkthrough tutorials, and amid these lab days, attendance was not as proportionally impressive as F2017's shockingly high rates (see Figure 1). Although the lab content itself was largely the same, including the presenting teaching assistant, students were observably more reserved and independent in their short periods of available free time (Erdei, McCord, & Whittinghill, 2019).

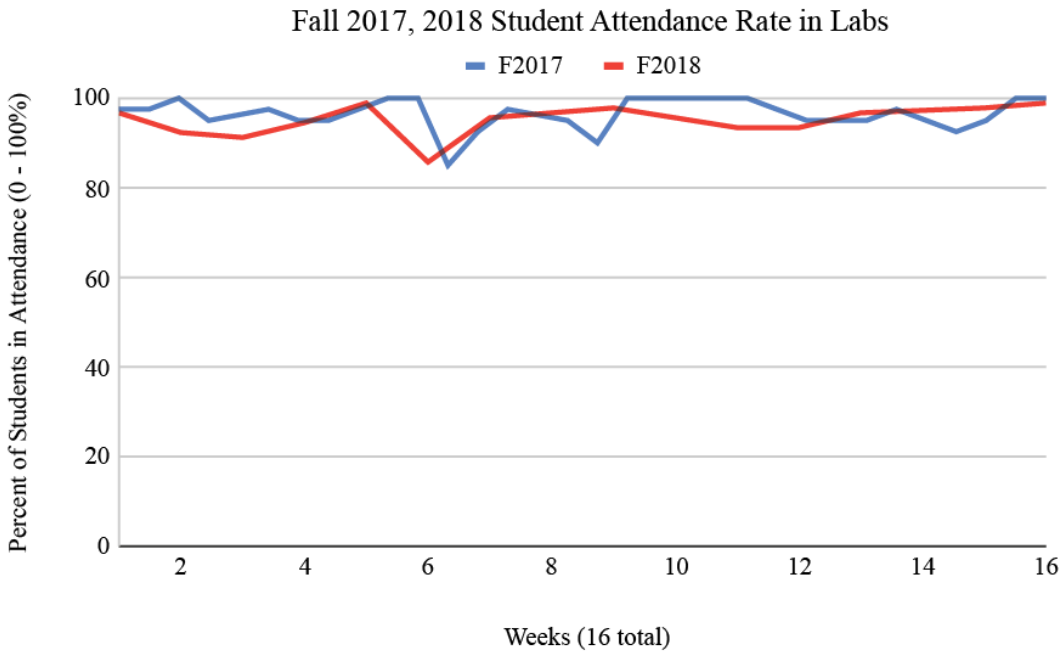

Figure 1. This graph visualize the proportional dips in attendance of Fall 2018 compared to Fall 2017; similarities in attendance are visible during a common time for midterm exams in other courses (week 6) and after group project work was fully implemented in both courses (week 9 in F2017, week 12 in F2018). Note that these graphs have been scaled to the same size to represent proportional change, as the total number of students differed between F2017 (n = 40) and F2018 (n = 91) (Erdei et al., 2019).

During the ninth week of the semester, group work began, and with it, attendance rates began to climb until they achieved the same proportional rates as the unusual F2017 data (Erdei, McCord, & Whittinghill, 2019). Even students who had been absent for nearly the entire first half of the semester returned for group work, contradicting expectations and research findings alike (Kivlighan Jr., 2012). Although these semesters are not truly comparable in their

circumstances and setup, their independent illustrations of student behavior derive interest and suspicion regarding a link between cooperative, interdependent work and attendance, setting the stage for data evaluation for the Fall 2019 (F2019) iteration of CGT Game Dev I.

F2017 and F2018 insights

Lab attendance was compulsory, graded functionally identically in each semester, with absences excused for serious documented exceptions of health and emergencies, plus one free unexcused absence for each student (worth approximately 4% of the total grade in F2017, and 7% in F2018). Each lab session is video and audio-recorded, then uploaded online for students to watch and review at any time; relatively high lab attendance rates suggest that students did not willfully skip labs, despite knowing that they could watch the recording later. This too raises intrigue regarding relatively strong attendance in F2018 and unusually strong attendance in F2017; the highest number of unexcused absences in F2017 were one student with six, one with five, and one with four, despite such a low grade incentive. Additionally, grading of work during project weeks was attendance based, rather than via submitted assignments. Students would need to bring their work to the lab to have it graded, but compared to the out-of-class individual assignments from early in the semester, project work grades from lab were significantly less impactful. Individual assignments were worth more than twice as many points as a week's attendance-based project work grade in both F2017 and F2018, and almost twice as much impact on the total grade. For example, F2017 students could skip half of their group work labs and still only lose about 5% of their total grade; yet, students did not elect to take advantage of the system in this way.

One noteworthy difference between the two semesters is the group work environment. F2017's island-style lab room did not include enough computers for each student, requiring

paired work during lab time, while F2018's greater number of smaller lab sections guaranteed every student a computer in a new, row-style room (see Figure 2). In F2017's room, with students stationed against the farthest walls or seated lower at island-style tables and no support beams to obstruct their vision, the whole room was visible at all times to any given student, whereas F2018 students lose their line of sight in the middle, and aisles are too far apart to communicate across comfortably or quietly. Although space is not investigated in this study, it is emblematic of a shift in cooperative capability, and may prove to be an outlet for future work.

The matching of optimal attendance rates during times of group work is the focus, and not without reason. In a relatively recent analysis of 211 students engaging in team-based learning, researchers Stein, Colyer, and Manning found that students would consistently rate their least involved teammates with the lowest values (2015); the conclusion to these findings was that students were indeed holding each other socially accountable for their work. With the intent to harness strong attendance, it is of this project's concern to define the deeper underlying

co-factors of accountability, motivation, and similar rapport-based attributes, if not thoroughly in the initial investigation of data, in consecutive replications of this study.

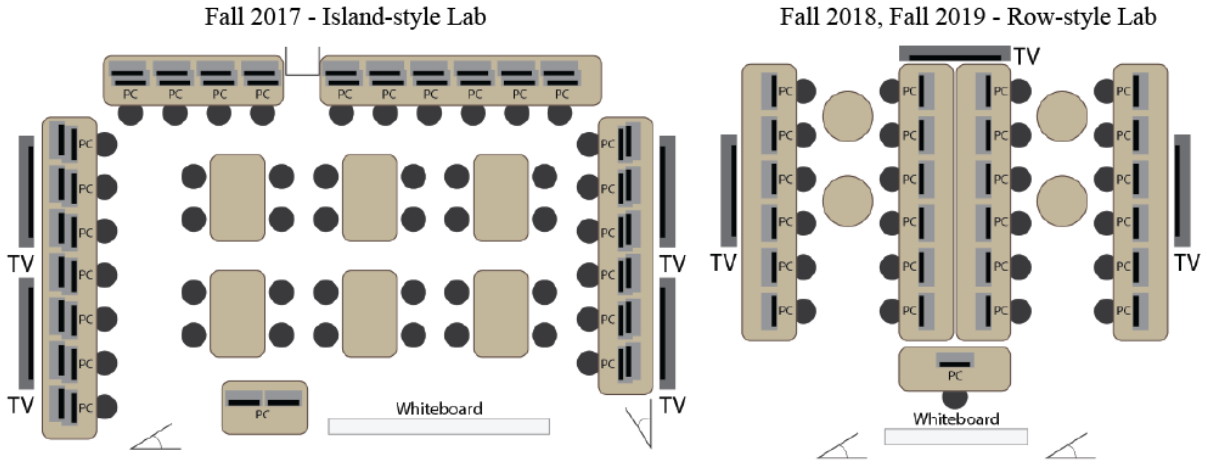

Figure 2. Simple visualizations of the lab rooms in Fall 2017, Fall 2018, and Fall 2019 (Erdei et al., 2019).

Through use of regular weekly surveys given to students for a small amount of grade points (around 5% of the total grade in F2017 and around 7% in F2018), self-report data were also collected and compared to trends in attendance. Self-reported attributes in F2018 that did not visually reflect any semblance of a positive nor negative relation to attendance include the average amount of hours spent on independent assignments, workload sustainability, peer comfort, and combined years of experience in Computer Graphics Technology, Computer Science, Computer Information Technology, and/or other related fields. Peer comfort self-reports from regular weekly surveys (for operational use by instructors) did improve when groups began using chosen partners as opposed to randomly-selected ones in the latter half of the semester, though this is likely due to students electing to work with peers they already felt comfortable with, as opposed to an overall growth in comfort with other classmates, as teams themselves did not interact much. Though visualization of these factors has not rendered noticeable patterns with attendance in their historic samples, such information will continue to be gathered in and beyond F2019 to deepen these data for longitudinal study.

Differences between F2017 and F2018

As aforementioned, it would not be fair to state these comparisons between semesters with confidence, only under the pretense of interest and generative curiosity. To restate, the qualities of these two semesters are compromised by a number of confounds, including but not limited to the change from a two-lab structure to a two-lecture one-lab scheme; the introduction of a co-instructor in F2018 and a differing co-instructor in F2019; lab room changes from F2017 to F2018; and lecture room changes from F2018 to F2019; a narrower pool of experience levels in F2017 (juniors at least) and F2019 (sophomores at least) compared to F2018 (a mix of the

concurrent sophomores and juniors); and inconsistencies in time of day of labs. Data collected in F2019 is evaluated only unto itself.

LITERATURE REVIEW

Search methodology

Extending investigations from a prior paper (Erdei, McCord, & Whittinghill, 2019), literature searching began with attendance and social terms, with the first lead arriving at social integration and retention (Braxton et al., 2013).

ERIC, ASEE Peer, and the general Purdue library databases were primarily utilized for gathering evidence, while Google Scholar uniquely helped to track some otherwise evasive referenced works to their roots. The following primary search terms were used:

- Attendance OR presence OR participation OR engagement
- Cooperation OR interdependence OR integration OR belonging
- Accountability OR retention OR motivation OR enterprise

Braxton and his colleagues' book opened the door to a number of related sources, from high-level theoretical social theories from Asch (1952) to focused, instructional-level theories of persistence, inclusivity, and social interdependence, the anticipated co-factor to be examined. These actionable theories of retention and social interdependence, being deeply and widely studied respectively (Braxton et al., 2013; Johnson & Johnson, 2005), fit comfortably in the bounds of greater learning theories (Asch, 1952; Lave & Wenger, 1991), and thus, their inspirations and empirical roots were valuable to verify as foundational evidence. Dissertations (Muller, 2008; Rivera, 2013) were explored for deeper comprehension of contemporary implementation of cooperation and related studies.

Literature summary pertaining to the purpose and its significance

The uncertain data of attendance

Preceding the assumption that more readily enforced mandatory attendance alone makes this perceived problem a non-issue, there are conflicting data and perspectives in this topic, with some finding that mandatory attendance resolves absenteeism (Snyder et al., 2014) and improves performance (Marburger, 2010) and others suggesting mandatory attendance enables student infantilism (Macfarlane, 2013) and that a non-mandatory environment improves performance for attendees and independent minds (Lukkarinen, Koivukangas, & Seppälä, 2016).

Beyond these discussions, external factors such as financial issues seem to undermine arguments of facilitation. Aggregated literature finds that students working through college or utilizing student loans will have higher attendance compared to those on scholarships or receiving financial aid from family (Moores, Birdi, & Higson, 2019); still, Kottasz's surveying with 155 students found 26% of non-attendant students missing lab-type tutorial classes due to work outstanding work commitments, and 14% doing the same for lectures (Kottasz, 2005). In the latter cases, motivation and affective components of student attendance may not matter much if work is what enables students to remain at an institution at all and does invade class scheduling, but researchers insist that facilitation and study of attendance factors for able students are worth exploring, such as creating a sense of belonging in the institution (Moores, Birdi, & Higson, 2019; Osterman, 2000; Wenger, 1998).

On the surface, evidence appears to be inconclusive, and Moores, Birdi, and Higson say as much in their review of the literature (Moores, Birdi, & Higson, 2019). Moving forward, they recommend that future research take on larger, longer studies which include a variety of modes of teaching and multiple ways to record attendance records to combat the weaknesses of current methods (e.g. user error in headcounts, multiple card registry with electronic monitoring). The

review does recommend completion of more extensive research, facilitation of attendance, and dissemination of formally used facilitation methods despite the conflicts present from individual motivations, individual circumstances, and the overall observed weakness of attendance studies at this time. Although this similarly exploratory study's scope does not allow multitudes of data or methods as recommended, its explorational premise is designed to extend longitudinally as recommended.

What is most important for this particular study is that mandatory attendance has not been enough to visibly stabilize attendance in individualistic segments of the course without noticeable, severe drops. To find the deeper truths to student attendance is to potentially unlock compulsory restraints in favor of an improved, empowered system of trust and feedback with students.

Return on investment

It may be assumed educational institutions benefit from attentive, socially included students. Osterman's synthesized findings on student participation (achievable by being in attendance) infer that drop-outs may primarily result from a lack of belonging in the normal social group, and that persistence and performance of students are significantly related to social belonging (2000). Reasonably, students retained by higher education facilities continue to pay tuition securely, providing a return on investment. With steady overall enrollment increases in the past few years for the game development track at the Purdue Polytechnic Institute, and 31% increase to Polytechnic undergraduate enrollment overall in the past six years (O'Malley, 2020), the difficulty in belonging in subcultures with many participants is a foreseeable risk to retention ("being lost in the crowd"), and therefore a risk to the institution.

It may be less readily arguable that student achievement yields a direct monetary return for higher education institutions, as achievement is subjectively judged by instructors within the institution, but it stands to reason that students who succeed in courses are indeed not dropping or failing out as well—recent evidence exists that attendance improves student performance in non-mandatory (Lukkarinen, Koivukangas, & Seppälä, 2016; Lyubartseva & Mallik, 2012) and mandatory classes (Marburger, 2010). Attendance as an influence on performance is only part of a complex multivariate comprehension of student outcomes, and despite research interest, may ultimately be superseded by other factors, such as prior academic ability (Snyder et al., 2014).

It is important to concede that most existing research focuses on more traditional fields and core competencies, whereas the insular trade skill-centric nature of game development curriculum may not be comparable to the mentioned investigated courses. Though, theories of social and situated learning (Lave & Wenger, 1991; Wenger-Trayner, 2011) represent the improved authentic outcomes and transfer of learning hands-on in socially contextualized, interdisciplinary groups in their stead.

The necessary analog of attendance

In the words of Dick, Carey, and Carey, "Seldom is something learned simply to demonstrate mastery on a test at the end of the instruction" (Dick, Carey, & Carey, 2014, p. 99). A student attending an educational institution does so because they have a problem: there is a real-world situation—a performance context—that they wish to succeed in, and they want or need the practice and knowledge to obtain that success. For CGT Game Dev I students, their anticipated performance context in the video game development industry requires the synchronous attendance of students.

Historically, video game development is a discipline handled in teams, designating roles for developmental, design, and market functions; even as early as 2005, industrial game development teams could have upwards of one hundred employees working in tandem (Reimer, 2005). Although games old and new have been developed by a single person (Hooper, 2016; Baker, 2016), these are outlying cases. In order for students studying and practicing video game development to experience a team-based industrial analog, they must be in attendance during class time to participate and cooperate with others. Else, their instructional needs are not being met. However, as highlighted by Jeong, Cress, Moskaliuk, and Kimmerle (2017), attendance itself is the weakest requisite element of joint interaction, in need of interactions such as cooperation to strengthen a knowledge community. In modern game development career environments, agile workflows are used to trade some amount of autonomy for rapid short-term planning in an overall iterative philosophy; it demands and begets heightened accountability and lower ambiguity of individual employees to mutually improve work efficacy and reduce exhaustive procedures (Sun & Schmidt, 2018). If attendance alone does not beget accountability or interdependent motivations to the work group, a measurable root variable should be verified, based strongly in theory (Johnson & Johnson, 2017).

The group context

Asch, seminal social psychologist and gestalt researcher, described that the goals of individual members of a group are ultimately contextualized through the group's enterprise, and further that self-interests do not survive without accommodating that socialized joint enterprise (1952). Levine (1999) notes that Asch did not observe nor promote the idea of social conformity, rather that information and the perception of information in the group led to actors transforming their behaviors, internalizing the group's trajectory in order to interact mutually. The concept of

social Darwinism and surviving interests, too, has been contextualized more modernly with effective business and industry, with Sanker (2012) outlining that collaborators in technology and innovation become powerful social units, “winners”; drawing from industrial experiences, he interprets that trusting diverse groups are resource-rich, primed to succeed over individualized or results-focused competitors that do not bond through their means. Wright (2001), cited by Sanker (2012), illustrated this effect in the consolidation of autonomous political entities over time, with 600,000 existing in 1500 B.C., and only 195 in the twenty-first century. The mutual goals of a collaborative group have the volume of supporters and benefit of multiple minds as a resource—or put more simply—if you can’t beat them, join them.

Further, as supportive of the group as Asch’s work may seem, the group unit alone is not a solitary beneficiary to its members (Hwong, Casswell, Johnson, & Johnson, 1993). To assume that a student could develop team-ready skills (Sun & Schmidt, 2018) without an information-rich synchronized social context—whether in-person or via distance means—could prove damaging to the experiential outcomes of career-pursuing learners.

Constructivism and discourse

In order to speak of curricular implementation and move toward methodology, it is key to ensure that the aforementioned group context aligns with instructional theories used for teaching video game development. For Purdue Polytechnic instructors, constructivism is the researched bridge of choice between groups in game development performance contexts and groups in game development learning contexts (Triplett, 2017).

Driscoll summarizes that constructivist learning employs meaningful context to facilitate learning (2005). The more a learning context can represent the performance context, the better aligned the learning outcomes are, and terminal objectives are more likely to be achieved by

students (Dick, Carey, & Carey, 2014). Therefore, for CGT Game Dev I students to learn in an environment matching their career's performance context, constructivism's contextual platform supports that outcome. If CGT Game Dev I can teach game development through socialized contexts, then students heading to the industry's group-oriented work style (Reimer, 2005) will be more prepared.

As a theory, constructivism has a variety of stems, but a central thrust toward discovery learning and knowledge generation (Driscoll, 2005). Instruction in the lab portion of CGT Game Dev I is designed to facilitate learning through light lecture introductions, applied hands-on work in labs to learn through interaction, and open-ended assignments which allow for interpretation of both the game dev techniques taught (e.g. a student may program a collision response from within the player character, or the object the character collides with) and the delivered product (e.g. to make a *win state*, one student flashes "You win" onscreen, while another forces the application to exit when the game is complete). The methods of work taught in the class are explained to be one way of doing things, where there are often several to many ways of solving a problem in game development, attempting to provoke students to construct techniques and styles from their own anchors and prior knowledge. In weekly course surveys from CGT Game Dev I, from F2017 onward, students often state that a sizable amount of their learning is independent, a measurement intended to roughly identify that students are indeed constructing knowledge willfully and actively.

However, the Fall 2018 iteration of the course's labs failed to facilitate this constructive learning through a context matching the performance context: social engagement nor group work were a led part of instruction until the second half of the course, when instruction would cease and group projects would begin. As aggregated by Driscoll, this fails to accomplish two critical

elements of a constructive learning environment: social negotiation (labs involved no peer to peer interaction), and the support of multiple perspectives (in this case, all knowledge was filtered through the single perspective of the instructor) (Driscoll, 2005). Muller's dissertation on multimedia learning also attests to the importance of discourse in learning, that individuals in a group can offer their perspectives, negotiate, and cull unreasonable knowledge and strengthen understanding (Muller, Eklund, & Sharma, 2008).

Situated cognition and communities of practice

These social psychological and constructivist cornerstones branch into situated cognition, the epistemological theory of obtaining knowledge through social, situational participation. By living in situations, we learn, which produces meaning, and Asch defined (1952), that meaning is created congruently with engaged, inseparable social context (Wenger, 1998; Wenger-Trayner, 2011). Situated cognition affirms that attentive everyday activity lends to learning that generalizes well beyond the insular nature of a generative situation, as knowledge is transformed for practical, satisfactory usage (Rogoff, 1984).

For students pursuing game development and related fields such as programming, this socially founded pragmatic mode of transferring knowledge is invaluable, as the design of games can create any non-zero number of technical and creative problems to solve. This may be evidenced by the popular use of online question forums such as the moderated Unreal AnswerHub for Unreal Engine 4 development software (Epic Games, 2009), or Stack Overflow's more generalized programming forum, which may feature upwards of 100 questions and answers per hour (Wiktor, 2019). In such environments, online users cross contextual boundaries to form solutions and share knowledge for problems existing in a greater context, from the use of a certain software or a particular programming language.

This theory does not go unchallenged by scholars, or even its own proponents. For instance, situated learning may not occur easily depending on the boundary between the subculture of the context and the subcultural of the learner (Damarin, 1993). Consider the comfort of extroverts in attending laboratory/tutorial-oriented classes, and the lack of comfort thereof for introverts (Kottasz, 2005); in such cases, the very context that serves as a font for learning stifles it for select learners. Even within the dimensions of the theory, it can be asserted that situational learning can invite "fossilization" in learning (Tripp, 1993, p. 72), generating knowledge that is comprehensible, but ineffective or incorrect in most other real-world contexts. The hypertext of virtual contexts within computer-based learning is also countered, as it deprives true context in the knowledge it delivers (Damarin, 1993). In total, Damarin's critique of and defense for the theory put forth a unique viewpoint, asking that it be regarded as travel, not tourism (1993), which draws attention to the involvement of presence, and therefore attendance, in situ.

Applications of situated cognition

Like all good instructional theories, situated cognition is at its best in conscious application. Operational practices of situated cognition include legitimate peripheral participation (Lave & Wenger, 1991) and communities of practice (Wenger-Trayner, 2011), executing highly transferable activity through use of hands-on working groups. According to Wenger-Trayner (2011), a community of practice is a group of learners who share three essential components: mutual engagement, a joint enterprise, and a shared repertoire, in accordance with Asch's (1952) note that all information in a group is socially oriented. Other elements of effectiveness have been associated with communities of practice, such as C4P (purpose, conversation, connection, connection, content, and context) in a study on emulating the environment of a real-world IT

consultancy (Fearon, McLaughlin, & Yoke Eng, 2012), but their reflections reveal that the bottom line remains the same—a common purpose is established, with the added benefit of developing transferrable skills and membership in a legitimate working community.

In step with Asch's (1952) elaborations of the group and interpretations of his work, individual goals that neglect or disrupt those internalized goals of the group naturally do not survive (Johnson & Johnson, 2003). With unification of the group thanks to those three defining essentials and active roleplay of an individual in the community unit, legitimate peripheral participation can occur, evolving participation into an insider identity that persists as the group grows and changes over time (Lave & Wenger, 1991). Those on the inside of a community of practice are effectively authentic performers of what they learn by doing.

If a student does not attend for course activities and group work, their ability to internalize group goals, integrate into the repertoire shared by the group, and learn transferable skills in that fruitful social context is lost. Inversely, a student who attends can expect to become positively invested in their socialized learning of knowledge and participation with others, not only in bound small work groups, but in the larger social context of the lecture or lab space by way of mutual engagement and shared interests (Wenger-Trayner, 2011). Collaborative, performative attendance cyclically improves the quality and incentives of attendance.

Literature summary pertaining to the methodology

Social integration and retention

Selecting a target factor to investigate is best done on shoulders of solid literature, and Braxton's writing team delivered on the topic of student persistence and long-term retention in higher education (Braxton et al., 2013). The interactionalist theories of Tinto (1975; 1986; 1993) framed a student's commitment to a higher education institution as longitudinal, dependent on

the interactions a given student has with the institution and its structural and social systems, not unlike the interactionist-bred theory of situated cognition (Jenkins, 1974). A sociological lens is used to identify voluntary student dropouts as a product of these formal and informal interactions—of social integration. Social integration embodies perceptions of social affiliation and congruence with social norms, at the institutional or subcultural level (Tinto, 1975).

Tinto's postulations were engaged, empirically assessed, and ultimately revised by Braxton and his colleagues through a decade of research and inductive theory construction. The revised theories of Braxton et al. (2013) outline that social integration is a key indirect factor affecting students' commitment in residential colleges and universities (e.g. Purdue University, the focal point of this study) by way of six antecedent factors: "ability to pay; commitment of the institution to student welfare; communal potential; institutional integrity; proactive social adjustment; and psychosocial engagement" (Braxton et al., 2013, pp. 85–92). Aside from ability to pay, these factors were inductively arrived at through conceptual factor analysis.

Recognizing the studied performative and institutional fiscal value of student retention, and that adequate attendance (i.e. to not drop out) is in part a short-term component of retention, it would be wise to put this knowledge of retentive antecedents into action at the class level, early in college careers. Factors external to learning institutions such as financial capacity have been studied in relation to attendance (Anders, 2012), but among these antecedents of social integration, the two that could most reasonably be influenced at the instructor-level are communal potential and psychosocial engagement, due to their accessibility in the individual's subcultural interactions. In the interactional overlap with situated cognition, it is possible that the subcultures fostered in social integration may draw boundaries across which learning affordance

may suffer (Damarin, 1993). Thus, it remains important for methodological use of these tenets of social integration to unite groups of learners, and to be wary of exclusive bubbles.

These factors align with visible trends in CGT Game Dev I F2018's historical attendance data, displaying that attendance improved in times of serious communal group work. Should a measurable social factor aligning with the discussed antecedents be isolated through research, it could be engaged from the start of a semester, foreseeably replicating the steady attendance rates observed in F2017 before.

Under the assumption that long-term persistence is achieved in part by sustaining attendance, the research of Braxton and his colleagues highlight and reinforce the potential positive impact of an operationalized, measurable social factor on student attendance, more specifically through communal and/or psychosocial engagement. The measurable social factor in mind, aligning with previously elaborated social knowledge and theories, is social interdependence.

Social interdependence

Social interdependence (Johnson & Johnson, 2005; Butera & Buchs, 2019) is one such construct that fits well within the parameters of these student-level social antecedents. In short, social interdependence posits that individuals' outcomes depend on the action and interference of others. Interacting—simultaneously or sequentially acting contingently with others—can drive the attainment of joint goals or obstruct them (Johnson & Johnson, 2005). The attendance and participation of individuals in a group situation affords interaction, and the binding nature of this interaction bolsters dependence on one another, positively or negatively (Deutsch, 1949). A construct formed in the mid-1900s (Deutsch, 1949, 1962), social interdependence has been in steady use and under study in the early-2000s (Johnson & Johnson, 2005) with over 1,200

studies whose data register a validating effect size (Johnson & Johnson, 2017). It represents the tenets of social, situational, and academic theory discussed prior with the capacity for internally reliable instrumental measurement (Johnson, Johnson, & Anderson, 1983). Though the theory of social interdependence serves as a foundation for other theoretical pathways, such as conflict resolution (Deutsch, 1973) and goal theory (Covington, 2000), its basic premise does address this study's socially-centered questions of attendance motivation, and its outcomes concur with the social psychological theory and literature base it is built on (Johnson & Johnson, 2017).

Social interdependence may be used as a framework to address the motivation of individuals (Tran, 2019) with some precedent in cultivating positive collaborative interaction in higher education (Rivera, 2013), which is a target interest of this study, but to do so, it must be acknowledged that context readily affects the motivation being framed (Johnson & Johnson, 2003). Johnson and Johnson clarify that the positive or negative context of social interdependence (and thereby its effect) is identified by way of the following considerations:

> (1) the value or benefit of the goal (i.e. mutual benefit, differential benefit or self-benefit); (2) the perceived ability to achieve the goal (i.e. joint, differential, self-efficacy); (3) intrinsic and extrinsic motivation; (4) epistemic curiosity and continuing motivation; and (5) commitment to succeed (Johnson & Johnson, 2003, p. 142).

These attributes are used to differentiate between three different context-driven motivational codes (see Figure 3) (Johnson & Johnson, 2003). Positive interdependence, also referred to as cooperation, is identified by benefits and efficacy shared in the group, curiosity stimulated by opposing viewpoints, an internal source of motivation, and high commitment to the group. Competition, or negative interdependence, is adversely is qualified by differential

benefit and efficacy, such that some benefit more than others, or instead of others; motivation is drawn from these comparative differences and potential to seize benefits, and opposition excites defensive behaviors rather than curious ones, all underscored by a low commitment to succeed. Finally, an individualistic context is bereft of social interdependence and social functionality, with benefits, efficacy being self-derived, motivation occurring from external sources, and without the inherent presence of another to challenge the individual, low commitment is sustained (Johnson & Johnson, 2003).

Table 9.1 Social interdependence and motivation

Co-operation	*Competition*	*Individualistic*
Mutual benefit	Differential benefit	Self-benefit
Joint efficacy	Differential efficacy	Self-efficacy
Intrinsic motivation	Extrinsic motivation	Extrinsic motivation
Epistemic curiosity aroused by opposing views	Defensive adherence aroused by opposing views	No intellectual challenge
High commitment	Low commitment	Low commitment

Table 9.2 Efficacy and motivation

Co-operative	*Competitive*	*Individualistic*
Advantages of joint efficacy	Problems with differential efficacy	Advantages of self-efficacy
Ability	Ability	Ability
Resource management	Contingent self-esteem Defensive avoidance	
Effort	Effort	Effort Transformation into competition

Table 9.3 Expectations for successful achievement

	Co-operative	*Competitive*	*Individualistic*
Own abilities	+	+	+
Other's abilities	+	−	0
Own efforts	+	+	+
Other's efforts	+	−	0
Previous history	+ or − Joint efficacy	+ or − Differential efficacy	+ or − Self-efficacy

Figure 3. Charts delineating the contextual and performance differences between cooperative and competitive interdependence, and with individualistic behavior (D. W. Johnson & Johnson, 2003, pp. 142, 155).

These contextual attributes are key in shaping the neutral movement from self-interest to a group orientation, led by processes relative to the individual, but inseparable from the group and situational context if one's goals are to survive (Asch, 1952; Johnson & Johnson, 2003). For example, one of Asch's key notes on the topic of interdependence is that setting aside one's intrinsic self-interest for the goal of the group is an intrinsic behavior of its own, elevated to the group level to accomplish greater tasks and to benefit from the accessible shared enterprise. Peer pressure is not inherently cooperative or competitive, but through active engagement, dependent on the context, interdependence can occur, yielding benefits from a facilitated value of commitment (Wicklund & Brehm, 1976) to on-task behavior (Johnson & Johnson, 1989), with active engagement being a common antecedent (Johnson & Johnson, 2003).

This being said, cooperative action—positive interdependence—appears to return the most favorable results in impact and frequency (Johnson & Johnson, 1989). One example is cathexis, a neutral psychological investment in external facilities such as family or work; competing for a goal and failing produces a negative reaction (Diener, Suh, Lucas, Smith, 1999), turning over negative emotions in kind and potentially less incentive to commit to competitive goals in the future. Cooperative action was found to generate more positive emotions than competitive or individualistic action, evidencing that those risky, negatively fueled behaviors ironically cannot compete (Johnson & Johnson, 1989).

Viability of positive interdependence as a co-factor

As this study seeks to investigate whether collaborative group work reliably forms a high-commitment, accountable atmosphere as seen in F2017 (Erdei, McCord, & Whittinghill, 2019), Johnson and Johnson's cooperation is the most appropriate motivational mode to pursue

(Johnson & Johnson, 2003). Of the three contextual codes, cooperation is the only one marked by high commitment of an individual in a group, and its exclusive shared properties appear to serve a group's members well. Not only do the mutual aspects appear in the lab-format group project work of CGT Game Dev I by the way of communities of practice (Wenger-Trayner, 2011), but the stimulation of curiosity through opposition is common in agile game development workflows, planning and developing a project in rapid sprints by embracing change in the developmental process (Sun & Schmidt, 2018). The benefit of this opposition in a positive way is supported by constructivist branches of learning in modern studies of multimedia and discourse, positing that students engaged in dialogue and discourse will cope with said discourse to reconsider preconceptions and appreciate co-existing hypotheses (Muller, 2008).

As negative interdependence—competition—is the alternative interdependent context within the construct of social interdependence, it is worth noting competition was considered as a co-factor of interest, but its attributes and outcomes do not align as well to the interdisciplinary team-based career environment of video game development as well as cooperation (Reimer, 2005). As further clarification, in relating positive interdependence scales to competitive learning measurements, Abrami and Chambers found little to no relationship between the two contexts (1994).

This is not to say that competition does not have its values. Cooperative company groups in industries such as video game development must compete with other companies for market dominance and consumer interest. Within the Purdue Polytechnic Institute itself, researchers utilize adaptive comparative judgment in order to accurately normatively rank student project performance within the university and in middle schools (Bartholomew, Nadelson, Goodridge, & Reeve, 2018) and define factors that affect student success in open-ended design (Bartholomew

& Strimel, 2018), which enforces a type of competition as students may procedurally rank each other's quality of work (the model is not limited to student-to-student comparison). Historically, however, implementation of this adaptive comparative judgment evaluation method in the F2017 semester of CGT Game Dev I was not conducive to some students' development as openly reported in regular weekly surveys, citing intimidation and lack of mutual criteria as obstructions of the comparative process. Considering this prior experience and mismatch to the class's performance context, negative interdependence is not sought after in this study.

In the grand scheme, the outcomes of cooperation best fit the insights of relevant rooted social theories, particularly those discussed and valuable to this exploratory study. Johnson and Johnson (2005) noted that results of cooperation—positive interdependence—included persistence through difficulty and higher intrinsic motivation, a key attribute in revised interactionalist theories (Braxton et al., 2013) as well as transferrable learning, heavily ascribed to participatory situated learning and communities of practice (Lave & Wenger, 1991; Wenger-Trayner, 2011). Resulting psychological adjustment and social competence is observable alongside positive relationships in the group dynamic, in concurrence with empirical results of proper social integration in residential higher education systems (Braxton et al., 2013). These theoretical commonalities are lacking in the negative and individualistic contexts of social interdependence. Through critical examination and rigorous study, social interdependence is a fixed gear in seminal social psychological theory, congruent with the web of findings from other social psychologists, closing the circle and acting as a credible co-factor (see Figure 4) (Asch, 1952; Braxton et al., 2013; Johnson & Johnson, 2003; Wenger-Trayner, 2011).

Implementation for positive interdependence

Despite brief preceding elaborations of Asch's theories of the group (1952) potentially misleading that group benefits arising from the group's existence alone, via some innate internalizing potency, continuing studies of social interdependence enlighten that forming a group alone does not yield desirable results (Hwong, Casswell, Johnson, & Johnson, 1993; Mesch, Johnson, & Johnson, 1988). Higher education instruction attempting to attain benefits of positive interdependence must cultivate activity and an environment that affords cooperation, with the process taking priority over the content itself (Johnson & Johnson, 2017). This means that the methods of operationalizing positive interdependence for this study and future works do not begin and end with measurement.

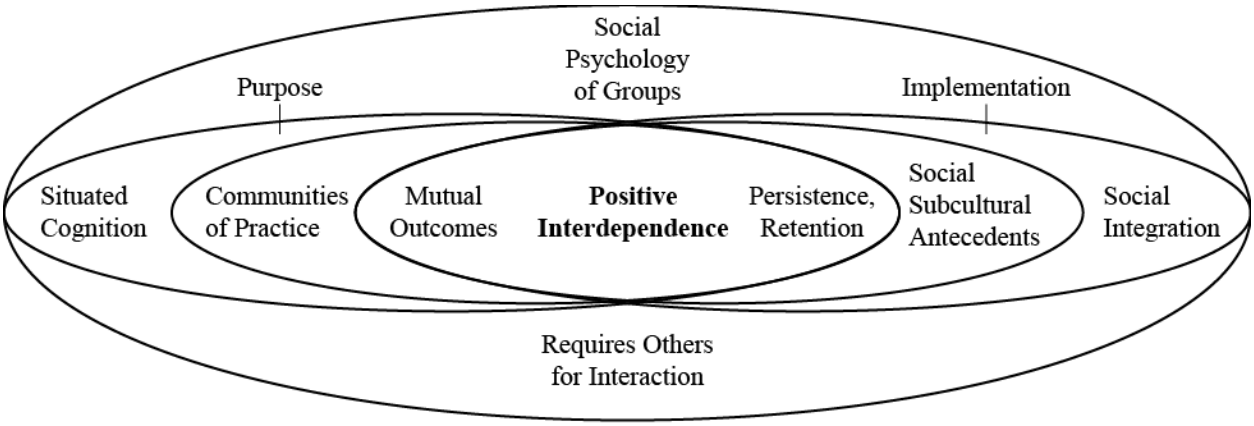

Figure 4. An operational diagram of the foundational arrival of positive interdependence as a co-factor of interest.

The systematic design of instruction encourages the development of instructional facilitation strategy and learning content based on the needs of the learners, accepting inputs and allowing for assessed output (Dick, Carey, & Carey, 2014); for the term evaluated for this thesis, F2019, group activities in both lab and lecture were designed with mutually valuable and epistemically stimulating participation in mind, as to create such a system of instruction. More specifically and somewhat reflexively, classroom research by Johnson and Johnson states that

structuring cooperation requires instruction to afford: positive interdependence tethering individual success to the success of others; individual accountability assessing each individual's contributions; promotive interaction inviting group members to support each other; appropriate use of social skills to behave reasonably and actively in the group context; and group processing leading to reflection and self-improvement strategy (2017). These elements have indeed existed in past group project facilitation in CGT Game Dev I, and have been used mindfully to structure new informal cooperative activities (Johnson & Johnson, 2017) in F2019, hoping to foster positive interdependence early as seemingly observed in F2017 (Erdei, McCord, & Whittinghill, 2019). Though the historical nature and scope of this exploratory study already limits empirical certainty, to design instruction without these pre-instructional elements would deny the findings of social interdependence researchers (Johnson & Johnson, 2017; Hwong, Casswell, Johnson, & Johnson, 1993; Mesch, Johnson, & Johnson, 1988).

Progress reports on social interdependence and cooperation as a topic of research discussed the limitations of the theory's existing body of literature (Johnson & Johnson, 2005; Tjosvold, D., Druckman, D., Johnson, R. T., Smith, K. A., & Roseth, C., 2019). Despite the wide breadth of applications of social interdependence performed by researchers, these applications were primarily comprised of theoretical and demonstrative studies, with the former lacking practical credibility and/or demonstration of the proposed social interdependence procedures, and the latter hosting a variety of weaknesses, not limited to high potential bias, doubtful methodological rigor, and a fixation on elementary schools over higher level education institutions. Opponents of social interdependence theory have historically suggested that meta-analyses of the primary authors do not well defend against selected strong empirical works, as the meta-analysis procedure flattens critical complexities in the theory's practice. Yet, these

meta-analyses may represent a key value of social interdependence application. Researchers of the theory across a range of over 1,200 studies (Johnson & Johnson, 2017; Tjosvold et al., 2019) have referred to it as highly generalizable.

Even so, reviews of existing literature on dependent variables such as student retention (Johnson & Johnson, 2005, 2009) have not directly referred to attendance as a prominent point of interest. Fortunately, analogous precedence does exist for this study. For instance, although somewhat conflating collaboration with cooperation, Wagner synthesizes the works of a number of industrial professionals and educators to identify cooperative benefits toward attendance in school under pretenses such as heterogeneous groups, the social skills required to navigate with the heterogeneous makeup, and the shared responsibility tied to a common goal (2002). Such heterogeneous groups can be seen in introductory video game development courses, which hail enrollment from students pursuing programming, fine and digital arts, user experience, animation, web development, networking, design, and entrepreneurship at the Purdue Polytechnic Institute.

A more career-oriented study followed an interdisciplinary group of video game developers and educators, from grad students to experts, in working collaboratively with users to create an educational virtual reality game that engaged positive interdependence in both its development and gameplay (Wang et al., 2019). By iterating using user feedback, the developing team created a more intuitive and less frustrating product experience, which turned users into mutual stakeholders with the developers. The game design itself discovered value in cooperation as well, finding that diving resources and information between two players with one shared goal cultivated a positive interdependent context: joint efficacy from readily parsing information for each other, generated curiosity for knowledge from productive failures and the intrinsic will to

perform well at the game's real-world scientific premise, underscored by commitment to the game and product by way of delivered feedback on the difficulty and experiences of the game (Wang et al., 2019).

Very similar to the interests of this study on cooperation and attendance in higher education, Rivera's dissertation on a community college algebra course investigated the course's low completion rate, structuring both formal and informal cooperative activities in order to improve persistence and retention through positive interdependence (2013). Outside of quantitative improvements, Rivera commented on sensing a notably strong community built in the class, sounding familiar to the communal behavior and impressive attendance of CGT Game Dev I F2017. (Rivera, 2013).

Classroom activities included informal ice-breaker questions that drove students to interact, think-pair-share groups, and formal jigsaw activities that leaned on members of the group to bolster individual expert knowledge and teach the others in kind, forming accountability between members. Students would seek help in their groups and the class as a whole after adjusting to cooperative activity, reaching out to each other before the instructor, with even shy students would becoming involved thanks to a perceived safe learning environment (Rivera, 2013). Such cross-student and cross-group collaboration was observed in F2017, in which students similarly had worked together from the beginning of the semester (Erdei, McCord, & Whittinghill, 2019).

Rivera's students came forward with expressions of transformed excitement toward math, a demonstration of intrinsic motivation cultivated through cooperation, all underscored by normally high attendance, rare absence, and a significantly reduced withdrawal rate (Rivera,

2013), in-line with theoretical bases for social integration and cooperation (Braxton et al., 2013; Johnson & Johnson, 2003; Lave & Wenger, 1991; Osterman, 2000).

Precedent of the Classroom Life Instrument

Approaching instrumentation for this study involved a historic investigation of social interdependence analysis. In the late 1970s, David Johnson and Ardyth Norem-Hebeisen developed scales of measuring attitudes toward the three distinguished contexts of social interdependence—cooperative, competitive, and individualistic (1979). Their goal was to examine theoretical relationships between these contexts, and examine whether they exist along a continuous spectrum, as well as advance measurement methods for educators. In doing so, they found scientifically and theoretically agreeable results to start: the three contexts did not exist along a single dimension, and that further investigation of these subfactors was warranted to confirm this. Although the measurement tested a limited range of ages of students, it was found that the scales were more cohesive on older tested students, an important underlying consideration which benefits this study on college-level students; the negative relationship between cooperative and individualistic measurement of older participants compared to younger testers was also heightened, suggesting that the college students tested would experience experiences distinct in cooperation compared to individual work.

The Classroom Life Instrument

Following the development and initial testing of these social interdependence scales (Johnson & Norem-Hebeisen, 1979), measurement of social interdependence, as well as assessment of its measurement instrument, has been rigorously performed by its proponents. The Classroom Life Instrument was published by the aforementioned David Johnson, Roger Johnson,

and Douglas Anderson (1983), surveying 859 students (grades 4 through 9) at the classroom level with 59 five-point Likert scale questions, designed to evaluate the impact of numerous measures of cooperation and including Cronbach alpha values of internal reliability for reference. The 1983 iteration of the Classroom Life Instrument was selected for use in this study for its wording of questions to the subjects being studied, as well as recent review concerning its field use (Voight & Hanson, 2012) and convenience of access. Measures of competition and individualistic codes are not included, as deemed not necessary for this study: classroom research of the tool has demonstrated little overlap between these contextual modalities (Abrami & Chambers, 1994; Johnson & Norem-Hebeisen, 1979), thus likelihood of mixed motivations are expected to have a minimal effect on measured results.

Reliability and validity of the Classroom Life Instrument

According to estimates by contemporary authors of social interdependence in 2017, over a thousand studies have been successfully completed since the 1940s, suggesting that social interdependence as a factor is reliable to measure, even if reports of the Classroom Life Instrument's usage hasn't been notably frequent (Johnson & Johnson, 2017). The authors state that social interdependence measures are highly externally valid, conducted across more than a century of time have been engaged in a vast array of research topics, from expected fields such as psychology and anthropology to more distant domains including economics and political science (Johnson & Johnson, 2005).

An overview of the Classroom Life Instrument was performed by Voight and Hanson (2012) confirms that the subscales used in the instrument evaluate a given student's "school connectedness, emotional and social competency, and voice and involvement" (Voight & Hanson, 2012, p. 5).

Like most instruments, the Classroom Life Instrument has faults to acknowledge. For instance, its primary usage was limited to American (Johnson & Johnson, 1983) and Canadian (Abrami & Chambers, 1994) testing, which may not harm its use in this study, but can impact generalizability of this study's results. However, the Cronbach alpha values for subscales of variables highly important to this study (cooperative learning, student personal support, resource interdependence) were considered satisfactory (≥0.7), and other important subscales were not far behind (positive goal interdependence, student academic support, and alienation were ≥0.6 but <0.7) (Johnson, Johnson, & Anderson, 1983). Additionally, the iteration of the instrument being used was tested largely on students in grades 4 – 9. Considering its use in this study, the age demographic initially tested with the instrument is lower than preferable, but the social interdependence scales introduced prior and developed in part by David Johnson noted that the questions were more cohesive for older participants (Johnson & Norem-Hebeisen, 1979). This argument of increased cohesiveness may also partially quell concerns of value judgments being made throughout the survey, which Abrami and Chambers noted could be confounding between their eighth-grade students' interpretations (1994).

METHODS AND PROCEDURES

This exploratory study analyzes historical data from the Purdue Polytechnic Institute's Fall 2019 (F2019) sixteen-week CGT Video Game Development I course (CGT Game Dev I). Not all data collected in F2019 is statistically analyzed within the scope of this paper (see Figure 5).

Participants

All F2019 CGT Game Dev I students, who were sophomores or beyond, were considered participants, though due to unforeseen technical difficulties in survey distribution and some student non-responsiveness, not every retained student's data was analyzed (n=56); two students of an initial 61 dropped the course, one before week 2 after attending the first lab, and one during week 7 without attending any labs and only one lecture, both minimal peer impact and without any submitted work or surveys to be sampled; three students had mismatching data sets that would disrupt analysis. All students belonged in the same group, without a control comparison due to existing limitations of sample size and length of study. This study generalizes participants as members of the population of higher education introductory game development students, though one perspective could internalize this sample as the entire population of Purdue University's introductory CGT game development students as well, as CGT Game Dev I is a required course for those in the game development track.

Each week, every student attended two one-hour-long lectures—one on Wednesday and one on Friday—and one registered two-hour-long lab session of three possible section times—either Monday, Tuesday, or Thursday morning. Two co-instructors presided over lecture sessions of the course, while all labs and data collection were conducted by the teaching assistant. Six

student producers—students who had taken CGT Game Dev I in Fall 2018 and passed with high marks—mentored and assisted groups of students during the collaborative second lecture session of each week, as well as guided final project teams in lab starting in week 9 of the semester.

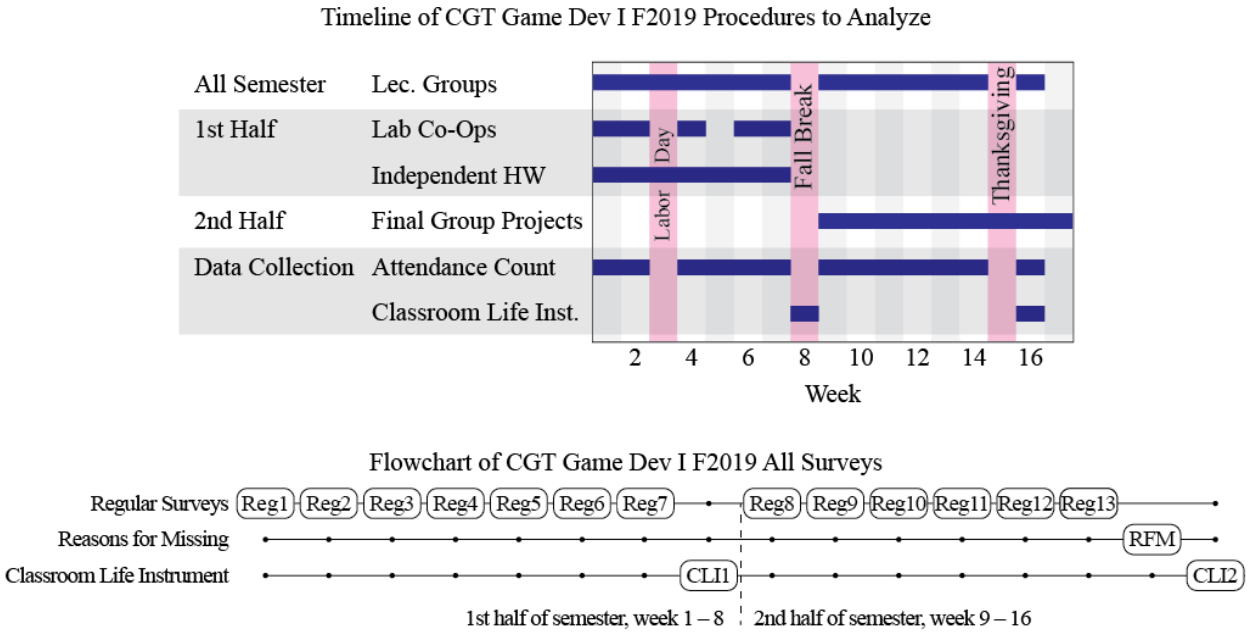

Figure 5. Gantt chart depicting the modes of work throughout the semester and when relevant data was collected. Flowchart illustrates all collected survey data, including from instruments not in the analysis scope of this study.

Due to personal reasons, one student could not stay for in-lab Co-Opportunity activities at the end of lab sessions, though they would still participate in groups during one lecture a week. For caution, an effect on this student's results is anticipated.

Attendance policy

On the first day of lab, students were told the attendance policy: every student was allotted one free unexcused absence without question, and any additional unexcused absences subtract ten grade points from their total grade (less than 0.5% of their grade, with attendance accounting for about 6.81% total for regular students or 6.15% total for honors students). Excused absences included documented illnesses, grievous or emergency family situations (e.g.

death in the family), conflicting professional appointments or visitations (e.g. medical checkup, career fair attendance, interviews), and exceptions outlined by student disability forms made known to one or more class instructors. A student who arrived to class, no matter how late, was not considered absent, though they were marked as late as a data category. Students who missed lab in the first and second week were sent an email reinforcing the attendance policy, stating that they had used their one free absence, and that further absences may result in lost points. During week 8 and 9, all students were reminded that their attendance is graded and mandatory to dissolve the misunderstanding of an inquisitive student who assumed final project work would be performed outside of lab classes with optional attendance, which foreseeably may have affected attendance rates in that time period.

Context

General approach to class conduct

All instructors (two professors, one teaching assistant) committed to being personable and optimistic in their instructional attitudes and lecturing style. Playfulness was important to the atmosphere of the class, particularly during times of group work, when students were encouraged to explore inquiries and problems that involved open-ending thinking. Instructors would engage with groups to comment on their work and provide support when given the chance.

Instructors did their best to remember student names and call out with them to build rapport. The author memorized most names by the fourth week, and had memorized all student names soon after.

Students in lab sessions were not required to reproduce the steps of hands-on walkthroughs, particularly if they preferred to pay full attention to the classroom video monitors or take notes. With all lab slideshows being open to students for downloading right before the

first lab of the week, students could preview or backtrack through content at their own pace. In lab sessions, the teaching assistant openly welcomed questions to be asked at any time during hands-on walkthrough demonstrations and would personally visit student workstations to assist stuck students before moving on.

All lab sessions were video and audio recorded, then uploaded within the first two days of the week (often on the afternoon of the first lab day of the week), enabling students to reference the procedures that were only demonstrated, not included in slides. In some cases, a lab recording later in the week would cover extra content, answer a valuable question, or simply be of higher quality than the first recording of the week; in those cases, the recording provided to the students would be replaced with the best version. A secondary benefit of recording the video lesson live was that some student questions would be included in the recording, which could potentially aid students encountering duplicate issues, or generate epistemic curiosity with opposing information upon watching and listening after the lab date.

In-class cooperative activities

During F2019, collaborative lecture and lab activities were facilitated each week to foster positive interdependence (barring week 3's lab due to Labor Day and week 5's lab due to unexpected time limitations) (see Figure 5). Group lecture activities always occurred in the second of two lecture sessions each week, engaging large groups of nine to twelve or small groups of two to four students with various brainstorming and documentation activities. For instance, in week 1, lecture instructors and student producers facilitated large groups in order to conceptualize the hypothetical work required to create an existing game, using an image of the game as visual reference; other activities had students form their final project groups early and

begin preproduction of their project, documenting concepts and expected parameters of their upcoming work.

For nearly each lab session preceding final project work, a Co-Opportunity (Co-Op) activity was performed in the last ten minutes of class, in which small groups of two to four students would answer three to four open-ended questions based on the lab session's topic and learnings. Students wrote their answers on a class-wide shared Google Doc such that each team could see each other's answers above or below theirs, while the teaching assistant would occasionally make supportive comments while walking around the room. The first three Co-Ops in lab week 1, 2, and 4, used randomized groups, and week 6 and 7 used the final project groups that students formed in their lecture activities. In order to cultivate a cooperative, motivational context, tenets of social interdependence were structured into each question (Johnson & Johnson, 2003): question 1 would favor opinionated responses to draw out intrinsic motivation; question 2 would present an open-ended problem to solve to generate epistemic curiosity and potential opposing views between group members; question 3 would require conceptualizing a piece of a game project or an idea for a project, enticing a mutual benefit to have ideas ready for later in the semester; with the group succeeding as one unit, joint efficacy could be realized as students worked together to expedite an agreement on an answer, or divide and conquer to complete the questions more quickly.

Beginning in week 9, halfway through the semester, lab sessions are dedicated to students working in their final project groups, meeting with their dedicated student producer to negotiate and assign individual game development tasks for the mutual game project; each team also meets the teaching assistant in order to grade attendance, to grade completeness of any tasks assigned the week before, and to receive help with technical problems. Final project tasks were graded

individually each week, but the whole group received an identical grade for the final submitted product.

Regular surveys

Since F2017, surveys have been distributed to students at the end of each week as regular class activity and continue in F2019. These surveys are graded for a small number of points; in F2019, lab attendance and survey participation are graded identically, ten points for each week. These regular surveys request students to self-report their feelings about each week's events with a mix of 7-point Likert scale questions and open-ended writing prompts. Although graded as mandatory, not every student completes every survey, typically obtaining between 50 to 55 responses in a given week. Currently, these weekly surveys serve an operational purpose, and may serve as the basis for future research beyond the scope of this study.

Each weekly survey was distributed on Friday, often at 11 AM, but occasionally later due to unforeseen circumstances. Additionally, reminders for a weekly survey were distributed the following Monday and Wednesday in order to achieve higher response rates. In order to remain consistent with prior semesters, distribution emails and reminders included varying messages to help students recall what the week entailed, to restate that completing the survey earns grade points, and to add some levity. Though these extra messages are expected to have minimal effect on student response behavior, it is worth noting that they are not controlled, nor consistent from one semester to another.

Classroom Life Instrument

With permission from the authors, the Classroom Life Instrument (Johnson, Johnson, & Anderson, 1983) took the place of the regular weekly survey in week 8, and replaces the regular

survey in week 16. To reiterate, the version of the instrument being used is only one of several iterations of the instrument, and was selected due to discrete focus on positive interdependence as opposed to measuring all contexts of social interdependence in broader measurement, high Cronbach levels of initially measured internal validity (Johnson, Johnson, & Anderson, 1983), relatively recent review (Voight & Hanson, 2012), and convenience of access. It features 59 unique 5-point Likert scale questions, meant to measure the level of positive interdependence achieved in the class (Johnson, Johnson, & Anderson, 1983). Minor alterations have been made to the wording of questions for appropriateness: “instructors” replaces “teacher; “assigned work” replaces “assignment”; “work” replaces “schoolwork”; “they” replaces “he/she” accordingly; “parents/guardians” replaces “parents.” Two questions have also been removed, as they do not apply to grading in the course. An additional note precedes the survey stating that “group” should holistically reference the group work and partner activities performed throughout CGT Game Dev I.

For the purpose of maintaining nuance and exploring positive interdependence deeply, the Classroom Life Instrument’s subfactors’ survey scores are being statistically analyzed as opposed to a holistic analysis.

Reliability and viability of procedures

As described by Johnson and Johnson, social interdependence and thereby positive interdependence is a measure whose reliability has been established through hundreds of tests across the century; it is highly generalizable as an operationalized factor in numerous different research fields (Johnson & Johnson, 2005), and the Classroom Life Instrument in particular has acceptable levels of internal validity (Johnson, Johnson, & Anderson, 1983) indicated by recorded Cronbach values. It is anticipated that repeated longitudinal use of these instruments in

this continued research condition will illustrate stronger, more reliable results than what is achievable in a single semester context.

Statistical Analysis

Variables delivered for analysis in this study include data from the F2019 iteration of CGT Game Dev I lab: lab attendance proportions from weekly lab roll calls and positive interdependence scores using the Classroom Life Instrument (Johnson, Johnson, & Anderson, 1983). The analytical goal of this research is to investigate the equivalence of attendance between the first half (independent work and Co-Ops in lab) and second half (full group project work in lab) of the semester, to identify whether the collaborative activities of each half are similar in effect.

To analyze the maintenance of lab attendance across both treated halves of the semester, a paired sample t-test of each student's attendance proportion from the first half and second half of the semester was conducted with a confidence level of 95% (α=0.05); similarly, to determine the equivalence of positive interdependence for both treated halves, a paired sample t-test of each student's positive interdependence subscale scores (e.g. cooperative learning, positive goal interdependence) from the Classroom Life Instrument was conducted, also with a confidence level of 95% (α=0.05).

RESULTS

The paired sample t-test of average, proportional attendance in the first and second halves of the semester did not yield a significant difference (p=0.055), suggesting that students' overall lab attendance rates in the individual-focused and group-focused halves of the semester were comparable in effect, and therefore worth investigating further for underlying subfactors and

Table 1: Proportional Lab Attendance t-test

Test subfactor	H1 Avg	H2 Avg	p value	Highly similar across halves?
Attendance	0.892857	0.938776	0.055	Yes

Table 2: Classroom Life Instrument Survey Positive Interdependence t-tests

Pos Interdependence Subfactor	Cronbach's alpha value	H1 Avg	H2 Avg	p value	Highly similar across halves?
*Cooperative learning	0.83	4.356293	4.487245	*0.035	*No
Positive goal interdependence	0.61	4.202381	4.327381	0.184	Yes
Resource interdependence	0.74	4.130357	4.239286	0.257	Yes
Teacher academic support	0.78	4.504464	4.629464	0.063	Yes
Teacher personal support	0.80	4.227679	4.361607	0.124	Yes
Student academic support	0.67	4.066964	4.209821	0.100	Yes
*Student personal support	0.78	*3.921429	4.035714	0.221	Yes
*Class cohesion	0.51	*3.653571	*3.739286	0.266	Yes
Fairness of grading	0.61	4.221429	4.339286	0.099	Yes
**Achieving for social approval	0.72	*2.935714	*3.253571	*0.012	*No
*Academic self-esteem	0.61	*3.425000	*3.582143	0.093	Yes
*Alienation	0.68	*2.520455	*2.542208	0.785	Yes

* denotes failure of one or more research goals: subscale a) did not receive a score of >4 (<2 for alienation) and/or b) was significantly different between halves of the semester

refinement of operations (see Table 1). As expected, lab attendance steadied and generally improved in the second half of the semester during compulsory groupwork (see Figure 6).

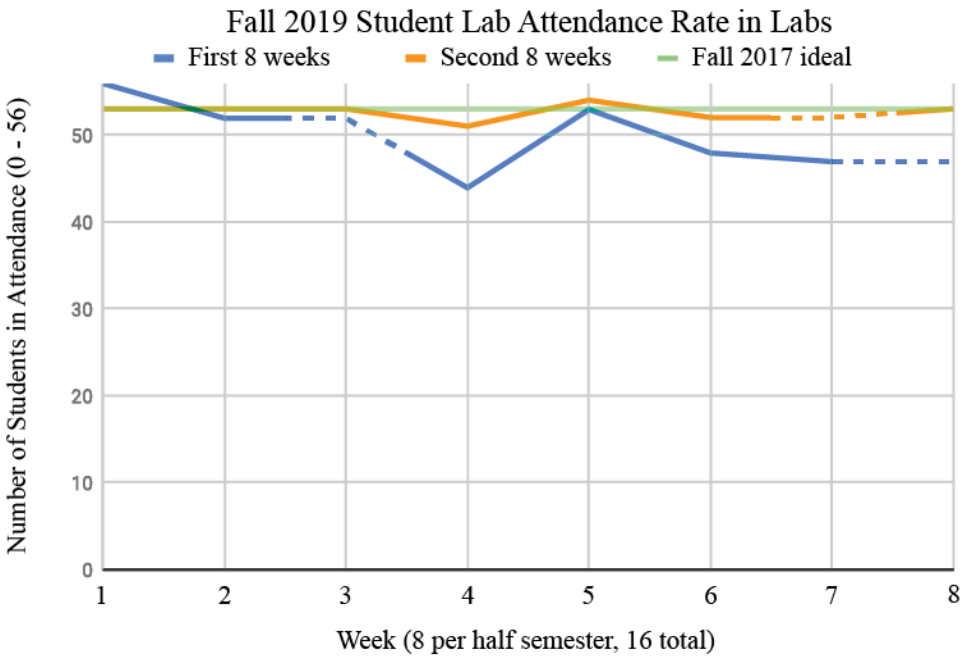

Figure 6. This graph visualizes the attendance patterns of game development students (n=56) across two halves of the semester. Dotted lines display when attendance was not collected due to mandatory break days: Labor Day on week 3 and Fall Break on week 8 of the first 8 weeks, and Thanksgiving Break on week 7 of the second 8 weeks (week 15 overall). Due to inconsistency between days to attend across halves, data was analyzed proportionally. A line scaled to proportion shows the ideal high values pursued from the Fall 2017 semester of interest.

Ten of the twelve subfactors of positive interdependence did not yield significant results, suggesting that the individual and group-focused halves of the semester did not significantly differ (see Table 2): positive goal interdependence ($p=0.184$), resource interdependence ($p=0.257$), teacher academic support ($p=0.063$), teacher personal support ($p=0.124$), student academic support ($p=0.100$), student personal support ($p=0.221$), class cohesion ($p=0.266$), fairness of grading ($p=0.099$), academic self-esteem ($p=0.093$), and alienation ($p=0.785$).

Of these successful subfactors, those with sufficient Cronbach alpha values of internal validity ($\alpha \geq 0.7$) from the survey's initial testing (Johnson, Johnson, & Anderson, 1983) include resource interdependence, teacher academic support, teacher personal support, and student personal support.

A 4 or greater average score of “agree” was the target score for each subfactor, or in the case of alienation, less than 2 for “disagree”. All subscales except for alienation improved by the end of the group work half of the semester compared to the individual-focused half, though very slightly in many cases. Student personal support, class cohesion, achieving for social approval, academic self-esteem, and alienation did not reach adequate average responses in terms of their effect. Achieving for social approval and cooperative learning were significantly increased in the second half of the semester ($p<0.05$), though cooperative learning did receive high subscale scores overall.

DISCUSSION

Distinct differences existed between the curriculum, conduct, and resulting attendance of the F2017 and F2018 versions of the course. Considering this, the design and structure of F2019 could be key in interpreting its results as well. Although the findings indicate that the core goal of this study was met—to simulate cooperative group work in individual-focused portions of the introductory game development curriculum—these stabilized variables did not necessarily meet favorable or ideal levels. The following observations and anecdotal suppositions are synthesized from the instructors of CGT Game Dev I, primarily the author, who was the lab teaching assistant and co-instructor of the course (designed all lab content with professors overseeing; facilitated and graded all lab content). These observations cannot exhaustively describe the insights of the instructors, rather they represent the most noteworthy conditions and circumstances at Purdue Polytechnic Institute which can anchor the findings for more general applications.

Interpreting attendance

Attendance was proportionally steadied across both halves of the semester, but the quantity of attendance did not quite achieve that of F2017's group work session, the current ideal. The difference could be interpreted to be negligible or coincidental, particularly given the statistically insignificant measurement between the two halves of the semester.

Several observations are worth sharing. First, past years commonly see a drop in attendance around week 6, assumedly because that is when midterms often begin in other courses; students may be electing to skip lab (for extra time devoted to studying, sleep, etc.) and catch up using the lab video recordings (weeks 4, 5, and 6 received the most watch time and

views of the semester's lab content videos). The week after Labor Day often also sees a drop in attendance, possibly because the students' routine has been disrupted. However, the leap in attendance in the lab between week 4 and 6—week 5—is not so easy to characterize.

As week 4 began the programming curriculum (which is typically less in the comfort zone of CGT's visual and artistically-oriented students) it is questioned whether the students who missed week 4 struggled to catch up on the programming content on their own, then making sure to attend for week 5 in-person. Supporting this theory, week 3 did have a video recording made and shared despite the lab did not meet in-person for any students because of the holiday, but its view count was half that of weeks 4, 5, and 6, with only 12 views in the first week out of 59 active students in the course at the time. The programming content videos from week 4, 5, and 6 not only featured the highest view counts and times, but have continued viewership later into the semester and beyond according to the embedded YouTube analytics; therefore, it is not unlikely that the perceived difficulty spike for non-attending students in week 4 motivated a strong return in week 5. Thoroughly exploring challenging content in class could be a key to persistent retention.

Interpreting cooperative learning

Cooperative learning and achieving for social approval both increased significantly in the second half of the semester, which is to be expected when engaging in group work, but fails the intent of this research procedure—ideally, such high survey scores would be achieved beginning in the first half of the semester and maintained into the second with little variance, which would suggest that the Co-Op activities in the individual-focused portion of the semester and group activities in lecture throughout the semester were effectively cultivating positive interdependence like full group work.

On the other hand, cooperative learning scores were at favorably high values regardless (well above 4.0 average, students "Agree"); students appear to be optimistic about cooperating, which helps to eliminate broad concerns about competitive or individualistic students interfering with collaboration. Other peer-focused subscales with inadequate score results but steady scores across halves of the semester, such as with student personal support and class cohesion, may have occurred from the impact of extrinsic elements of group work, without much influence from students' internal attitudes toward cooperation.

Next steps for cooperative learning

Seeing as no singular question for the cooperative learning subfactor received lower than a 4.25 out of 5 on average in both halves of the semester, it may be appropriate to say that this subfactor achieved the research goal regardless of the significant difference between halves of the semester.

On the other hand, if adequate results were not achieved and the significant difference between halves of the semester remained, explicit coaching could potentially affect beliefs about cooperation in the individualized portion of the semester (e.g. describing how teaching a fellow game developer in the industry how to swap placeholder objects in the world with new assets using a shortcut improves their efficiency, and reduces any overflow that you could become responsible for). Though, higher education students could find this behavior obnoxious if overdone or presented insincerely.

Interpreting goal and resource interdependence, and student academic support

An unusual interaction exists in student academic support, which features questions concerning friendliness and concern for one another, but with a slant toward class activity (e.g.

"other students want me to do my best work," and "other students care about how much I learn"). It received higher scores than another student-to-student subfactor, achieving for social approval, which queries the importance of other students' expectations and opinions of the individual's work. It is possible that the amount of time students spent using work as a social activity (lecture activities, lab Co-Ops) completed students' internal reasoning that the individual's success is important to others, and confirmed that productivity and accountability are mutual goals in their own game development pipeline. High average scores in positive goal interdependence resource interdependence appear to qualify this perception of communal goals and support, particularly in the dimension of coursework, as students concurred on average that success is a product of synchronous individual contributions.

Interpreting teacher academic and personal support

It is possible that the high scores for teacher academic support and teacher personal support are in part due to extraordinary circumstances: the author's reduced graduate course load, intent to practice teaching as a career, and research involvement being tied to the course enabled more time to be spent on student attention.

The author prioritized student needs wherever possible in the course. For questions or concerns that could not be addressed during class time, the author invited students to reach out via email at any day or time, and in almost all cases, did respond immediately or within the day. Larger problems would be answered by the author by creating and sharing a video tutorial—in these cases, the video would then be uploaded to Blackboard (Purdue's Learning Management System of the time) where any student could benefit from watching. Assignment grades were also often assigned within a week's time of the work being due (sometimes as early as a few days after the deadline), allowing students to receive feedback before their next submission.

The author also customized a few of their in-person office hours according to students' votes in order to accommodate students who may not have been able to attend otherwise. These office hours were added on top of the regular required number of weekly office hours.

There is a chance that the author's quick responses to students' questions inversely affected students' opportunities to socialize with each other, as student personal support and class cohesion did not receive adequate scores, though student academic support's adequate score does put this into question.

Interpreting student personal support and class cohesion

Student personal support barely missed a 4.0 average score in the first half of the semester, but class cohesion scores did not fair quite as well, steadied between 3.6 to 3.7 out of 5 on average.

The attitude-centered questions of cooperative learning paint a different picture than the experience-based questions of student personal support and class cohesion. While cooperative learning asks questions such as "I like to share my ideas and materials with other students," and "it is a good idea for students to help each other learn" and received high scores across the semester, student personal support and class cohesion measure the reality of the situation: "In this class, other students like me as they like others," and "all of the students know each other well". In a way, these questions may more truly reflect interpersonal conduct in the course, and if so, warrant attention and improvement at the peer-to-peer level of interaction.

The current course design leaves lab classes packed with content to achieve the minimum amount of learning goals before group work begins, rarely leaving time for unstructured social activity. Lectures and lecture group activities are similarly low on time to spare, meaning that all meaningful social interactions in dedicated course time is associated with work (visible in higher

scores in student academic support). Further, students do not have a choice in who they are grouped with until the second half of the semester, as they are grouped randomly for lab Co-Ops or by lab section in lecture activities. Although this is designed to combat alienation by having most students engage with each other in a Co-Op experience at least once, alienation scores were also not adequate (above a score of 2 on average; adequate scores would be below 2): change, either in or out of the classroom, should be made.

Next steps for student personal support and class cohesion

Seeing as teams for group activities were not arranged by student choice in the first half of the semester, enabling more choice in future iterations could improve chances of students building stronger interpersonal bonds by way of intrinsic motivation in the cooperative context (Johnson, Johnson, & Anderson, 2003).

One early attempt to help link students took place on the first day, as students stated their name, amount of prior experience in their major, and their favorite video game: the hope was that students would take note of others who have similar tastes, but without the ability to personally choose partners, that social opportunity was lost. Since lab groups are already restricted by the lab section's enrollment, and students are randomly mixed into small groups for Co-Ops, it may be most appropriate to allow lecture activity groups to be chosen by students. In this sense, however, students may become less familiar with their lab-oriented team members before group project team selection begins; something is gained, and something is lost.

If the course itself cannot support social engagements, an answer may lie in remote communication. In some recent CGT course facilitations, including 3D animation, lighting and rendering, and CGT Game Dev II, the teaching assistant has opened and moderated an online communication channel or group chat for all students who want to participate. If the teaching

assistant were to do the same for CGT Game Dev I, but then removed themselves from the communication channel, it would give students a private space to discuss the course freely without an institutional entity monitoring their behavior. Those who dislike or become tired of the channel could willfully remove themselves as the teaching assistant does, or simply disable notifications coming from it. It stands to reason that students could do establish such a channel on their own if they desired regardless of instructor initiation, so having an instructor initialize the space to start could demonstrate that it is an ethical and intentional fixture of the course.

Fortunately, since individual assignments in CGT Game Dev I are all productive and open-ended (students work in Unreal Engine 4 to make scenery, program interactions, and so on), even students who share assignment knowledge over a class-wide communication channel are unlikely to commit plagiarism, out of the sheer difficulty to replicate each other's hands-on work. Cases in which legitimate plagiarism do exist would continue to be easy to catch (e.g. things like programming have predetermined outcomes that would match on sight, as would digital scenes with copied coordinates and identical assets). Ultimately, students in the course are allowed and encouraged to learn independently through online tutorials as it is, so academic integrity is not a major concern with an unmoderated social channel, simply due to the nature of assigned work.

Interpreting fairness of grading

Students on average scored grading fairness strongly. The author believes that the methods and systems of grading being openly shared with students enabled teacher-student relations by lowering the power position of the instructors, and that perceived fairness of grading cultivates honest, secure bonds with instructors by way of certainty and transparency.

Since F2017, the CGT Game Dev I instructors have implemented an A/B/C grading system that guarantees any properly complete assignment work submitted on-time will receive a 70 (C- grade) at minimum.

- C, 70-79%: work is complete
- B, 80-89%: work has clear effort put in, has an appreciable quantity of work
- A, 90-100%: work is high quality, creative, advanced, and/or impressive

All assignments were open-ended in their construction with clear bottom-line requirements (for instance, select a dystopic novel and create a scene using meshes and materials, or program a mind-boggling amusement park attraction with real time motion and basic primitive meshes), so giving students clearly defined grade tiers encourages risk-taking on these summative assignments. For instance, if an artistic student was not certain that they could program effectively beyond what was taught in lab, they could develop more content to demonstrate practice and aim for a safe middle-to-high B, or flex their creative skills to leverage for an A. Students could also selectively frame their work to their advantage, as all submissions were recorded as videos, uploaded to the internet, and submitted as URL links to prevent large uploads to the learning management system (Blackboard) from failing (which also makes access convenient for the grader, no large downloads).

The author, acting as the teaching assistant and lab co-instructor, graded all assignments for the course. The author shared the grading methodology explained above with all students in the first lab, then elaborated the mentality behind awarding points: all grading was done positively, meaning that points were only added to the base score of 70, not subtracted. Understanding that CGT Game Dev I is an introductory course and that assignments were restricted to six days of work time including weekends, errors such as minor bugs or visual flaws

did not detract from scores. Additionally, every assignment received unique comments on the strengths and unique specialties of the work, in order to drive students to manifest an identity in their work instead of worrying about nitpicked flaws. According to the scores, this forward-facing approach was well liked by students.

In F2019, assignment grades for completed, submitted work ranged all the way from 70% to 100%, so the high survey scores of these questions are not likely to be based on inflated grades alone. C grades were infrequent compared to A and B grades, and only one retained student failed the course due to not submitting assigned work, so grades could appear inflated without context. However, most students completed adequate or exceptional work by the end of the semester; the author believes this score is appropriately earned with the grading systems in place.

Individualized comments from the author on all of the first semester assignments gave students positive feedback, often delivered to students one week after the deadline, or in some cases, only a few days after. Theoretically, this reduced stress by granting students valuable stress-preventative resources—teacher academic support (which scored highly as a subscale) and enough time to think about their work reception before their next submission (Hurst, Baranik, & Daniel, 2012)—and certainty, which cyclically enables ease of cognitive structuring, and in turn provides a sense of control (Bar-Tal, Shrira, & Keinan, 2013). This being said, this was achievable with an immense time commitment from the author—with around 6 minutes spent to quickly grade an assignment and writing an original comment, the fastest possible time to complete a week of grading would take 5 – 7 hours without breaks. The author, as a graduate student teaching assistant, was taking fewer courses than a regular course load, and therefore could afford to put more time into facilitation tasks such as this, so this may not generalize well

to other institutions and instructors. Yet, it is also possible that the author takes longer to grade than other teaching assistants; currently, no baseline of comparison exists, as the author has been the only teaching assistant for the course in this current curricular style.

To reduce time on grading effectively, a small amount of time in each lab could be dedicated to students peer reviewing each other's work, which lends additional benefits to the cooperative aspects of this course design, guarantees that the student receives feedback before the next assignment, and may encourage students to arrive on time to class. Additionally, having predetermined categories of strengths to assign to each submission (e.g. creative, atmospheric, clever) can give students attention to their unique skills, confirm that the teaching assistant is critically thinking about the submitted work, and provide an abstract reward separate from the grade given.

Interpreting achieving for social approval

Seeing as final group projects absorb the entirety of the second half of the semester's content work, it is not surprising that the importance of being perceived as skilled increased significantly once teams were officially formed. Ideally, students who found themselves in an underperforming group and had already registered for the follow-up course (CGT Game Dev II) would develop a new appreciation for standing out from the crowd and pairing with high performing peers, if only seeing the personal benefit they would receive. Yet, the numbers do not reflect this, featuring inadequate middling scores, even after the significant increase in the second half of the semester.

Many instructors in Purdue Polytechnic's CGT program emphasize the importance of portfolios and independent work in securing a job, and warn that careers in fields like game development and animation are difficult to come by, even for highly skilled students.

Meanwhile, although CGT game dev instructors would agree that independent work is valuable, CGT game dev students are encouraged to collaborate to make on portfolio content to make it more robust (i.e. a programmer's work can become more attractive with the help of an artist's modeling, and having an artist's models visible in a real-time game engine shows that they are well optimized for machine processing), and simply recommend to cite the contributions of others visible in the work. Perhaps the competitive sentiments dampen the social response from work, under the expectation that even instructors cannot measure their work's chances of earning them a job, and thus, extrinsically shaped feelings remain intact.

Next steps for achieving for social approval

It should be noted that these Classroom Life Instrument questions for achieving for social approval (Johnson, Johnson, & Anderson, 1983) externalize beyond the classroom. Still, with scores in the middle range, and considering that an important factor in students' late-semester success is forming a functional final project group, it is worth trying to raise these scores in the singular game dev classroom environment.

In past semesters of CGT Game Dev I, the teaching assistant has offered to broadcast "wanted ads" for students (students with a final project pitches seeking team members, or student requests to find a team in need of their skills), but students have rarely taken the opportunity. Taking the initiative to share highly successful examples of student work during each lab session may provoke the students' willingness to be seen as socially valuable earlier in the course (and provide a benchmark to work toward), and therefore drive them to submit high quality work, particularly if the same student(s) cannot be featured more than once. Yet, in the worst case, students struggling to develop high quality work may not see themselves as competitive and resign themselves to isolation. Ideally, weaker students would seek to join stronger students, but

by the virtue of only strong work being publicized, those featured students may also assume that they must team up, regardless of social fit with each other and to the disadvantage of weaker students. Overall, caution is recommended, and consent of any students to be publicized is key.

In CGT Game Dev II, the second course in the series, early assignments require students to playtest their games with others in order to collect data using in-game analytics, which they then report on. Including this activity in CGT Game Dev I may encourage students to find value in approval outside of the game dev classroom, though with assignments already being fairly intensive (when surveyed each week, students reported a mean of about 6 hours of work per week for this course), it may be difficult to conscientiously fit into the current curriculum without additional redesigning.

Interpreting academic self-esteem

Seeing that self-esteem is an underlying emotional component of work, the inadequate scores for this subfactor could be concerning, if not now, in the long term for students. In this subscale's questions, students agreed that they felt like they were learning in the course, but test anxiety and concerns of being able to do better than they currently were in school hint raise questions of whether greater attitudes and circumstances are involved.

The author has observed a trend in CGT students outwardly expressing their excessive work hours or remarking how little sleep they have gotten. In a way, these students seem to measure their success by their work-life imbalance. Overworking is seen as being contingent with success; if you had to work beyond your limits, you can safely assume the work is as good as it will get. Rarely do these same overexerted students congratulate themselves on a job well done, instead diminishing their results, or claiming that they are simply satisfied that it is complete. Seeing that academic factors scored well outside of this subscale, it appears that

students can identify academic security and support per the CGT Game Dev I environment, but overall lack academic self-esteem.

Beginning with F2019's iteration of CGT Game Dev I, weekly course surveys asked students to share the amount of work hours they performed for the class. The average was around 6 hours, which is the university recommendation (2 hours of work * 3 credit hours of CGT Game Dev I). However, outliers at both end of this spectrum tell a different story. According to the data, some students only worked one hour a week, and others worked eleven or more hours on a single week's assignment, enough to qualify as a student-held part-time job. More than one student in F2019 emailed the author about feeling personally disappointed in reasonably strong grades (in one case, a 96/100%) and asked how they could improve for future assignments. Several times in F2019, the author has arrived CGT Game Dev I's lab room around 7:20 AM to find a prior student (not a CGT Game Dev I student, but a student the author taught in a previous semester) who stayed in the campus computer lab overnight working, skipping sleep. A culture of college overwork is not unique to the CGT program, but its existence is a signal of curricular issues. Students appear to sacrifice their personal health to optimize an already high grade and rationalize that it is worth doing. Current pedagogical methods do not disincentivize this well enough on their own.

It can be assumed that CGT Game Dev students who are already achieving A-level grades but still overachieve and risk burnout are doing so for intrinsic motivations, but for ethical reasons, the low levels of academic self-esteem are an alarming call to action.

Next steps for academic self-esteem

Game development tasks during the second half of the semester utilized an agile methodology, which accepts each individual's external circumstances as a realized limiter to the

yield of work. In an agile work team, assuming responsibility for too much work hinders the team just as much as not doing enough. Therefore, during the second half of the semester in group projects, students negotiate the specific tasks that they believe they can accomplish in the given week (factoring in other responsibilities), and they will be held accountable for no more or less than that work. Grading for these tasks is proportional, meaning that a student who committed to one task and completed it would earn a 100%, while a student who committed to eight tasks but only finished four would receive a 50% grade for the week. In a way, this negotiated style of work resembles the adaptive nature of personalized learning systems, albeit with the lab teaching assistant and Student Producers acting in place of adaptive planning technology.

Adopting a similar personalized learning style in which students determine their own learning style, pace, and needs (Lin & Kim, 2013) for assignments during the first half of the semester could be valuable in assisting students with less time or low output to feel accountable for their grades and focus on marginal improvements or mastery, as well as encourage high performing students to feel satisfied with their workload commitments, even when they are particularly time-consuming. Unfortunately, fitting one-on-one negotiations into regular lab time will be difficult, and would require course redesigning, as to not sacrifice students' already narrow amount of time to cover critical lessons and participate in cooperative activity. Handling this remotely, or giving students full command over their personalized commitments would lose out on instructor curation and direct guidance, but would mobilize the process.

Interpreting alienation

Alienation survey scores were highly similar across both semesters (mean difference between the first and second half was an increase of 0.02), which did align with the objective of

the project, but the average survey scores around 2.5 (between students categorically "Disagreeing" or "Neither Agreeing nor Disagreeing" that they felt overall alienated in the class) are not desirable. Curiously, these poor average scores did not convert into absence in a broad sense, though it would be worth investigating whether those with the lowest alienation scores were also commonly absent or late students. If not, then considerations that cooperation and attendance are related would be weakened, potentially inviting the development of a new construct whose subfactors do align more sensibly.

Achieving for social approval subfactor had poor scores but leapt up in reported scores from one half of the semester into the next; strangely, alienation received poor scores but maintained nearly identical scores across both halves of the semester. It appears that alienation is formed and confirmed early, or at least is unusually resistant to change.

It is possible that the wording of the alienation questions being generalized to "school" in this subscale and others could have led to answers with sources or conditions unrelated to CGT Game Dev I: the worst-scoring alienation questions were "Whenever I take a test, I am afraid I will fail," "I should get along with other students better than I do," and "I am not doing as well in school as I would like to." Still, in the interest of understanding CGT Game Dev as a part of belonging at the institutional level, it is important to reflect on potential reasons behind these scores.

Alienation scores may be so consistent between both halves of the semester because lab enrollments were used to group up students in lectures (e.g. students in a 7:30 Monday lab were assigned to work together during cooperative lecture activities). If a student did not feel comfortable with their assortment of lab peers, there was little chance to socialize beyond that group, and no social opportunities formally implemented into the class.

Additionally, students were not allowed to form final project groups outside of their registered lab class time for institutional reasons, though a number of students asked to; in these cases, it is apparent that a student felt more accepted elsewhere, but could not formally engage with their liked peers, perhaps contributing to the poor alienation scores.

Historically, students in CGT Game Dev have been observed to seek forming groups with peers of common ethnicity and/or gender identity. In labs of less than 24 students, minority students could feel stranded and unable to grow relationships from a secure starting point. The randomized groups of lab Co-Op activities were designed to force students of differing backgrounds to socialize with each other, but seeing as these activities only lasted 5 to 15 minutes, the chance of a secure relationship forming then and there is unlikely.

It is understood that described feelings of isolation and/or lack of participation can undercut contrasting successes in positive interdependence, so reducing scores for this subfactor should be prioritized in future iterations, even if uneven across individual and group-based activity.

Next steps for alienation

To combat poor alienation scores, it would be wise to mix students into random groups more meaningfully. Encouraging healthy discourse and linking intrinsic motivation by requiring students to share subjective thoughts (opinion-based activities, rather than just objective completion) would more readily fulfill the positive qualities of interdependence (Johnson & Johnson, 2003).

Re-instating paired lab work from F2017 (Erdei, McCord, & Whittinghill, 2019) is also an option, though it is difficult to tell how well students will take to this in a mismatched environment: in F2017, there were not enough resources for individual work, making paired

work a necessity, but since the F2018 iteration of the class, the ratio of computers to students has provided each student with their own computer, which may not produce the same student-level inspiration to work together in lab.

FUTURE WORKS

Potential modifications in replication

Given the data and interpretations presented, it is apparent that significance and survey scores present a different image holistically than individually. Wholly, consistency was measured somewhat by way of lack of significant difference, but such probabilities are weak evidence on their own, especially when effectiveness is called into question.

Additional data not presented in this paper was collected for future analysis, to deepen the understanding of this information beyond its current limited setting. This includes categorical questions of students' reasons for attendance and non-attendance (Kottasz, 2005) surveyed on week 15, as well as weekly surveys created for operational purposes conducting the course including data on the amount of time spent working weekly, peer comfort, challenges, and other qualitative elements.

No measurement was made in differentiating the effect of lab Co-Op activities and the varying lecture group activities lead by lecture instructors and Student Producers. It is safest to assume that their combined effect produced the results observed, as even lab attendance alone cannot be an isolated product of lab activity and conduct. If literature is to be believed that external factors such as financial factors and jobs can affect attendance (Kottasz, 2005; Moores, Birdi, & Higson, 2019), the effectiveness of individual procedures in labs and lectures should not yet be distinguished as more or less effective than one another.

Though many unknowns are common to appear in educational research, those of the researcher's future interests include the influential priorities and intensity of other courses; CGT Game Dev I is an aggregate class of sorts, while students may carry a dedicated focus in animation, user experience, programming, or other component trades within game development.

Further, if the data of these subscales highlights continual success in some, but not all subscales, participating researchers may look forward to developing a new construct off the basis of positive interdependence and its theoretical grounds.

It is recommended that those interested in this research seek to expand the amount of data to reduce contemporary bias, introduce and maintain other data collection methods to sharpen interpretations of positive interdependence scoring, and improve the width of attendance data sets such that there is enough variance to statistically analyze associations with a valuable effect size.

Correlation

In discussing the potential for measuring association between attendance and positive interdependence scores, it was advised that the effect size of variance in attendance would be too narrow to produce the anticipated results. Smallness of effect size in attendance is not new in discussions of attendance (Lipscomb, Snelling, 2010), so it is anticipated that longitudinal study alone will not be enough to tease out secure results.

Should the interest in positive interdependence as a co-factor remains, future iterations of this study must look toward methods that will enable effective measurement. Expanding to both lab and lecture attendance could tease out a conclusive effect size, or in the interest of generalizing data, well as measuring attendance and positive interdependence subscales in other related higher education courses in the same program, such as 3D animation or introductory programming.

Other factors of study

With this study's explorative focus deep into cooperation, it is possible that other critical factors to sustaining attendance and cultivating positive interdependence are being narrowly missed and tempt broader investigation before another deep dive. If longitudinal results reveal some subscales of the Classroom Life Instrument (Johnson, Johnson, & Anderson, 1983) having consistent results, a new construct beyond positive interdependence may be created with those subfactors.

As aforementioned, measured cooperation results from lab were likely affected by both lab and lecture procedure. Yet, lecture attendance was not in scope of this initial study. Continuation of this study, as well as replicated or derived studies, are recommended to collect lecture attendance rigorously, and to measure cooperative experiences in both labs and lectures with personal discretion. A student may not be willing or able to distinguish and report their feelings on cooperation between labs and lectures, as those experiences are in some part related under the umbrella of class curriculum, but it is foreseeable that lecture and lab content could cultivate different results (particularly if conducted with different instructors, such as CGT Game Dev I holding professor-led lectures and teaching assistant-led labs).

In extension, the impact of Student Producers was not dissected, blending in with lab and lecture activity on the whole. Student Producers were not formally trained as mentors before entering the course and working with underclassmen students, but were vetted by the course professor. Seeing as studies of supplemental instruction report strong findings in raising retention and lowering withdrawal rates (Dawson, van der Meer, Skalicky, & Cowley, 2014), it would be very reasonable to pursue research identifying how greatly their effect is in this context, and therefore whether formally training Student Producers as supplemental instructors would be beneficial for video game development in higher education.

One operational model of group work in industry points to cooperation being only one component of collaboration (being used as a formal term), which encompasses unconsidered factors within the social interdependence model. Subfactors of interest in this operational model for collaboration include ongoing communication, diversity, leadership, and written affirmations from the individual team members (Sanker, 2012).

Outsourcing and remote game development

With the growth of the games industry and in a globalized world, some game companies turn to outsourcing as a modern economic solution to handling development costs; Yoo's summary of make-or-buy decision determinants in the games industry dates this practice long before games reached their explosive contemporary status (2005), and even earlier, Kramer illuminated the legal structures of conducting virtual business to the benefit of game developers (1997). Asset creation, cinematic rendering, or other procedures may be offshored, or even conducted from employees working at home in an agile way (Blur Studio, 2020; Coker & Lackey, 2016). Legitimate game development vocations exist without direct contact, which would seemingly not align with this study's focus on in-situ cooperation. Directing attention to cultivating cooperation remotely is relevant at the time of this paper's creation, with the COVID-19 virus leading to a great number of schools and companies transitioning to remote work very suddenly (Hadden, Casado, & Sonnemaker, 2020; McAloon, 2020).

Recent research links in webcasting and livestreaming may serve to bridge remote work to the power of in-person communications, and therefore, provide a new method for performative learning. One case study of a workshop conducted by major theorists Etienne and Beverly Wenger-Trayner establishes that in-person or remote presence is not a strong enough differentiating factor to interrupt legitimate peripheral participation, and instead that presence is

what is important (Wenger-Trayner & Wenger-Trayner, 2014). The pair conducted a workshop that connected some remote participants through webcams on laptops and smartphones, as if to view each other in-person for the day's events; notable insights from the session include the observation that those on devices could feel exhausted from depending on the on-site participants for movement, rotation, and assistance, as well as being swept around through new environments as the group relocated to new activities. These limitations and vulnerabilities seemed to evoke playful and inventive behavior from all those involved, challenged to communicate more efficiently and more effectively.

Typically, the inability to directly interact is a detriment to the theoretical advantage presented by communal activity, but the inability to directly interact is a reality for some individuals and companies, and therefore could be valuable to study through this lens of cooperation. Applying the Wenger-Trayner workshop method into education would be benefited in theory and implementation by reviewing communities of inquiry, a dialogic model of domain-based knowledge production (Dumitru, 2012) which recently sees use in online learning communities, facilitated by a traditional instructor, but with students directing the educational experience with the instructor's support (Peacock & Cowan, 2018). Such a model may be well at home in the case of the Purdue Polytechnic Institute's CGT Game Dev classes, as user experience coursework in the same CGT major currently employs a studio-style pedagogy with a high volume of student dialogue and leadership.

Another relevant alternative to this research thread includes the use of online streaming to connect with students. Game development educator and researcher Travis Faas uses the creative streaming platform Twitch.tv in order to teach from a computer synchronously with viewing students, resulting in the growth of learning-focused communities to the benefit of the streamer

and the viewers (Faas, Dombrowski, Young, & Miller, 2018). Though Faas's model engages the theory of communities of practice and its surrounding learning theories, it focuses on the leadership of a more knowledgeable other as a live instructor who is regularly watched by an invisible audience (participation typically includes inputting feedback through a text-based chat function directed at the streaming instructor).

In comparison, the work of Wenger-Trayner relied on two-way viewership of participants, seeing and being seen by their audience via webcam (Wenger-Trayner & Wenger-Trayner, 2014). Still, the subscale scores for teacher academic support and teacher personal support in this study were among the highest rated factors from the Classroom Life Instrument (Johnson, Johnson, & Anderson, 1983), and both appeared to maintain those high scores consistently across the semester. A strong focus on mentorship and an embracing of remote technologies as an extension of the cooperative classroom may substantiate the results already seen in this study while adding a new legitimate dimension of work experience, exploring distance learning as a performance context.

CONCLUSION

This exploratory study of higher education lab attendance and social psychological impact for video game development education has yielded information worth carrying forward into more rigorous research. A synthesis of prior literature led to positive interdependence as a target of investigation as a potential co-factor of attendance, as it aligns with understandings of higher education retention by way of encouraging belonging and high commitment in the social subcultural space, and because it can be implemented at the instructor level through well-defined, thoroughly studied cooperative activity in classrooms. Results of instrumental surveying showed the individualized and group-oriented halves of CGT Game Dev I to not be significantly different from each other in attendance and ten of twelve subscale factors of positive interdependence, suggesting that newly implemented cooperative activities garnered socially involved, attentive behavior during classwork without long-term, solidified grouping. Recommended future work includes longitudinal replication of this study to rigorously validate or invalidate the explored results, as well as branches into new constructs, supplemental instruction, and remote facilitation of cooperation.

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APPENDIX A. SURVEYS

Classroom Life Instrument (Johnson, Johnson, & Anderson, 1983).

TABLE 1
SCALES INCLUDED IN THE CLASSROOM LIFE INSTRUMENT

Scale and reliability	Items
Cooperative learning, .83	In this class: 51. I like to share my ideas and materials with other students. 53. I can learn important things from other students. 54. I like to help other students learn. 55. I try to share my ideas and materials with other students when I think it will help them. 57. it is a good idea for students to help each other learn. 58. I like to cooperate with other students. 59. students learn lots of important things from each other.
Positive goal interdependence, .61	When we work together in small groups: 8. we try to make sure that everyone in our group learns the assigned material. 14. our job is not done until everyone in our group has finished the assignment. 21. we all receive the same grade. 27. our grade depends on how much all members learn. 34. I have to make sure that the other members learn if I want to do well on the assignment.
Resource interdependence, .74	When we work together in small groups: 39. we cannot complete an assignment unless everyone contributes. 47. the teacher divides up the material so that everyone has a part and everyone has to share. 50. we have to share materials in order to complete the assignment. 52. everyone's ideas are needed if we are going to be successful. 56. I have to find out what everyone else knows if I am going to be able to do the assignment.
Teacher academic support, .78	My teacher: 22. cares about how much I learn. 28. likes to see my work. 33. likes to help me learn. 38. wants me to do my best in schoolwork.
Teacher personal support, .80	My teacher: 13. really cares about me. 15. thinks it is important to be my friend. 40. likes me as much as he/she likes other students. 43. cares about my feelings.
Student academic support, .67	In this class other students: 1. want me to do my best schoolwork. 5. like to help me learn. 17. care about how much I learn. 25. want me to come to class every day.

First of two pages of the original Classroom Life Instrument, used with permission in week 8 and 16 of the course (D. W. Johnson, Johnson, & Anderson, 1983, pp. 137–8).

TABLE 1 (cont.)

Scale and reliability	Items
Student personal support, .78	In this class other students: 7. think it is important to be my friend. 20. like me the way I am. 29. care about my feelings. 31. like me as much as they like others. 35. really care about me.
Class cohesion, .51	In this class: 2. are my best friends. 10. I like to work with others. 24. everybody is a friend. 41. I am often lonely.* 44. all of the students know each other well.
Fairness of grading, .61	In this class: 16. everyone has an equal chance to be successful if they do their best. 32. if a student works hard, he/she can definitely succeed. 42. students get the scores they deserve, no more and no less. 45. I deserve the scores I get. 49. sometimes I think the scoring system is *not* fair.*
Achieving for social approval, .72	I do school work: 9. to make my teacher happy. 12. because my classmates expect it of me. 23. to make my parents happy. 26. to keep my teacher from getting mad at me. 37. to be liked by other students.
Academic self-esteem, .61	3. I am not doing as well in school as I would like to.* 6. School work is fairly easy for me. 18. Whenever I take a test I am afraid I will fail.* 19. I am doing a good job of learning in this class. 46. I am a good student.
Alienation, .68	3. I am not doing as well in school as I would like to. 4. I find it hard to speak my thoughts clearly in class. 6. School work is fairly easy for me.* 11. I should get along with other students better than I do. 18. Whenever I take a test I am afraid I will fail. 30. I often get discouraged in school. 36. I have lots of questions I never get a chance to ask in class. 41. I am often lonely in this class. 46. I am a good student.* 48. I often feel upset in school. 49. Sometimes I think the scoring system in this class is *not* fair.

* The scoring of these items should be reversed.

Second of two pages of the original Classroom Life Instrument, used with permission in week 8 and 16 of the course (D. W. Johnson, Johnson, & Anderson, 1983, pp. 137–8).

Modified Classroom Life Instrument (Johnson, Johnson, & Anderson, 1983).

Shaded questions have been adjusted; asterisks (*) mark questions with inverse scores.

"Teacher" has been changed to "instructors"; "assignment" has been changed to "assigned work"; "schoolwork" has been changed to "work"; "he/she" has been changed to "they" accordingly; "parents" has been adjusted to "parents/guardians."

Two questions have been removed, not aligning with course grading and thus lacking clarity.

Scale	Number	Question
Cooperative learning		*In this class:*
	51	I like to share my ideas and materials with other students.
	53	I can learn important things from other students.
	54	I like to help other students learn.
	55	I try to share my ideas and materials with other students when I think it will help them.
	57	it is a good idea for students to help each other learn.
	58	I like to cooperate with other students.
	59	students learn lots of important things from each other.
Positive goal interdependence		*When we work together in small groups:*
	8	we try to make sure that everyone in our group learns the assigned material.
	14	our job is not done until everyone in our group has finished the assigned work.
	~~21~~	~~we all receive the same grade~~
	~~27~~	~~our grade depends on how much all members learn.~~
	34	I have to make sure that other members learn if I want to do well on the assigned work.
Resource interdependence		*When we work together in small groups:*
	39	we cannot complete assigned work unless everyone contributes.
	47	the instructors divide up the material so that everyone has a part, and everyone has to share.
	50	we have to share materials in order to complete the assigned work.
	52	everyone's ideas are needed if we are going to be successful.
	56	I have to find out what everyone else knows if I am going to be able to do the assigned work.

Instructor academic support		*My instructors:*
	22	care about how much I learn.
	28	like to see my work.
	33	like to help me learn.
	38	want me to do my best work.
Instructor personal support		*My instructors:*
	13	really care about me.
	15	think it is important to be my friend.
	40	like me as much as they like other students.
	43	care about my feelings.
Student academic support		*In this class, other students:*
	1	want me to do my best work.
	5	like to help me learn.
	17	care about how much I learn.
	25	want me to come to class every day.
Student personal support		*In this class, other students:*
	7	think it is important to be my friend.
	20	like me the way I am.
	29	care about my feelings.
	31	like me as much as they like others.
	35	really care about me.
Class cohesion		*In this class:*
	2	are my best friends.
	10	I like to work with others.
	24	everybody is a friend.
	41	I am often lonely.*
	44	all of the students know each other well.
Fairness of grading		*In this class:*
	16	everyone has an equal chance to be successful if they do their best.
	32	if a student works hard, they can definitely succeed.

	42	students get the scores they deserve, no more and no less.
	45	I deserve the scores I get.
	49	sometimes I think the scoring system is *not* fair.*
Achieving for social approval		*I do assigned work:*
	9	to make my instructors happy.
	12	because my classmates expect it of me.
	23	to make my parents/guardians happy.
	26	to keep my instructors from getting mad at me.
	37	to be liked by other students.
Academic self-esteem		
	3	I am not doing as well in school as I would like to.*
	6	Assigned work is fairly easy for me.
	18	Whenever I take a test, I am afraid I will fail.*
	19	I am doing a good job of learning in this class.
	46	I am a good student.
Alienation		
	3	I am not doing as well in school as I would like to.
	4	I find it hard to speak my thoughts clearly in class.
	6	School work is fairly easy for me.*
	11	I should get along with other students better than I do.
	18	Whenever I take a test, I am afraid I will fail.
	30	I often get discouraged in school.
	36	I have lots of questions I never get a chance to ask in class.
	41	I am often lonely in this class.
	46	I am a good student.*
	48	I often feel upset in school.
	49	Sometimes I think the scoring system in this class is *not* fair.

Questions on Attendance and Non-Attendance (Kottasz, 2005).

TABLE 1.

Reasons for missing:-	**TUTORIALS:** % agreeing or strongly agreeing with these statements	**LECTURES:** % agreeing or strongly agreeing with these statements
I can get the tutorial/lecture material in other ways	15%	38%
Tutorials/lectures are not worth attending	4%	6%
Times are not always right	38%	50%
Illness	45%	72%
Transport problems	44%	61%
Work commitments elsewhere	26%	14%
Poor content of tutorial/lecture	20%	23%
Poor tutor/lecturer	19%	23%
Tutor/lecturer has disregard for the student	10%	14%
Have to work on other assignments	28%	61%
Cannot be bothered	9%	15%

TABLE 2.

Reasons for NOT missing:-	**TUTORIALS**: % agreeing or strongly agreeing with these statements	**LECTURES:** % agreeing or strongly agreeing with these statements
Attendance is vital if I want to achieve good grades	93%	97%
The subject is difficult and complex to learn without help and guidance	65%	73%
Tutor/Lecturer is good	77%	76%
Lot of material is handed out and it would be difficult to catch up	69%	82%
Parents / family put pressure on me to attend tutorials/lectures	8%	20%
I am genuinely interested in the subject	81%	82%

Borrowed survey questions in asking for students' reasons for attending and not attending in week 15 of the course (Kottasz, 2005, pp. 10, 11).

Modified Questions on Attendance and Non-Attendance (Kottasz, 2005).

Shaded questions have been adjusted; asterisks (*) mark questions with inverse scores. "Tutor" has been replaced with "lab instructor"; "lecturer" has been made plural to "lecturers" with verbs adjusted to fit; "Lot of material is handed out" has been edited to "Lots of material is presented."

Reasons for missing (Lab):	**Reasons for missing (Lecture):**
I can always get the lab material in other ways.	I can always get the lecture material in other ways.
Labs are not worth attending.	Lectures are not worth attending.
Times are not always right.	Times are not always right.
Illness.	Illness.
Transport problems.	Transport problems.
Work commitments elsewhere.	Work commitments elsewhere.
Poor content of lab.	Poor content of lecture.
Poor lab instructor.	Poor lecturers.
Lab instructor has disregard for the student.	Lecturers have disregard for the student.
Have to work on other assignments.	Have to work on other assignments.
Cannot be bothered.	Cannot be bothered.
Reasons for NOT missing (Lab):	**Reasons for NOT missing (Lecture):**
Attendance is vital if I want to achieve good grades.	Attendance is vital if I want to achieve good grades.
The subject is difficult and complex to learn without help and guidance.	The subject is difficult and complex to learn without help and guidance.
Lab instructor is good.	Lecturers are good.
Lots of material is presented and it would be difficult to catch up.	Lots of material is presented and it would be difficult to catch up.
Parents / family put pressure on me to attend lab.	Parents / family put pressure on me to attend lab.
I am genuinely interested in the subject.	I am genuinely interested in the subject.

CGT Game Dev I Regular Weekly Course Surveys.

Questions 14 and 15 were not included in the week 1 version of the survey, as no assigned work had been completed yet.

Beginning in week 9, questions 14 and 15 replace "Lab assignment" with "final project work."

1. The lessons provided this week helped me to learn the material.

Strongly disagree | Disagree | Somewhat disagree | Neither agree nor disagree | Somewhat agree | Agree | Strongly agree

2. The percentage of my learning (total of 100%) this week came from: (100

Lecture: [sliding scale, 0 – 100]

Assigned Exercises (In-class or out of class): [sliding scale, 0 – 100]

Independent Research: [sliding scale, 0 – 100]

Collaboration with Classmates: [sliding scale, 0 – 100]

3. I feel confident that I now understand the lessons that were taught this week.

Strongly disagree | Disagree | Somewhat disagree | Neither agree nor disagree | Somewhat agree | Agree | Strongly agree

4. I felt comfortable interacting with my peers this week.

Strongly disagree | Disagree | Somewhat disagree | Neither agree nor disagree | Somewhat agree | Agree | Strongly agree

5. I felt motivated to interact with my peers during group work this week.

Strongly disagree | Disagree | Somewhat disagree | Neither agree nor disagree | Somewhat agree | Agree | Strongly agree

6. I felt included by my peers during group work this week.

Strongly disagree | Disagree | Somewhat disagree | Neither agree nor disagree | Somewhat agree | Agree | Strongly agree

7. I felt curious when my peers discussed differing opinions during group work this week.

Strongly disagree | Disagree | Somewhat disagree | Neither agree nor disagree | Somewhat agree | Agree | Strongly agree

8. My partner(s) interacted with me during group work this week.

Strongly disagree | Disagree | Somewhat disagree | Neither agree nor disagree | Somewhat agree | Agree | Strongly agree

9. I could explain the work I did and my reasoning behind it to another person.

Strongly disagree | Disagree | Somewhat disagree | Neither agree nor disagree | Somewhat agree | Agree | Strongly agree

10. I was challenged by this week's work.

Strongly disagree | Disagree | Somewhat disagree | Neither agree nor disagree | Somewhat agree | Agree | Strongly agree

11. The thing I found most challenging this week was:

[typed free response]

12. The thing I found easiest this week was:

[typed free response]

13. I feel the assignments this week were fair and appropriate given my skill level.

The following question requests that you share the amount of time you spent working on this week's final project work. *Your response(s) will not be utilized nor investigated until after all semester assignments have been completed, and your answer will not influence your grade in any way.*

14. Please select the approximate number of hours you spent working on this week's final project work (use 11 for any number higher than 10 hrs).

[sliding scale, 0 – 11]

15. I feel that the amount of work that I performed for this weekly Lab assignment was sustainable.

Strongly disagree | Disagree | Somewhat disagree | Neither agree nor disagree | Somewhat agree | Agree | Strongly agree

16. Please reflect on your experiences in the course this week and share any insights, thoughts, or feelings you may have had.

[typed free response]

APPENDIX B. COURSE INFORMATION AND MATERIALS

Fall 2019 CGT Game Dev I Grade Points

May be subject to minor change based on unforeseen circumstances.

Work	Amount of	Points Possible	Sub-Total	Percent of Total
Attendance	16	10	160	6.81%
Surveys	16	10	160	6.81%
Lecture Activities	16	15	240	10.21%
Quizzes	8	15	120	5.11%
Assignments	6	100	600	25.53%
Midterm	1	400	400	17.02%
Scrum Tasks	6	20	120	5.11%
Final Commentary	1	550	550	23.40%
Total			2350	100.00%

Fall 2019 CGT Game Dev I Co-Opportunity (Co-Op) Questions

No Co-Op was performed on week 3 as Labor Day rendered the lab session optional, and week 5's Co-Op was cancelled due to time limitations in the lab session.

Week 1: BSPs and Blockout

1. What genre of game do you feel needs level blockouts the most?
2. Suppose you are starting a project of that genre: why will good blockouts be important to the project's success?
3. Come up with a game mechanic that would still be fun to test in totally gray level blockouts!

Week 2: Meshes, Materials, and Imports

1. Why might we prefer to use static meshes over BSPs in advanced stages of a game project?
2. Name as many software options as you can for…
    a. creating static meshes:
    b. creating textures:
3. Come up with a game concept that would use many models but very few textures, or many textures but very few models!

Week 4: Lighting and Post-Processing

1. In a living room scene, list 3 props that would be best to have baked lighting/shadows, and 3 that would need dynamic lighting.
2. The art director says your scene looks too dark: how might you fix this?
3. Create a game idea that involves the distinct differences between point lights, spot lights, and directional lights!

Week 5: Blueprints and Variables (*not performed due to time constraints*)

1. What variable type would you use to store…
    a. a high score value.
    b. a custom spawn location.
    c. a custom save file name.
    d. a temporary poisoned status.

2. Describe at least one game that uses differing instances of a single object to create variety.
3. Think up a gameplay concept that would only require you to program the transformations (location, rotation, and scale) of your player character!

Week 6: Collisions and Casting

1. A collision in your game isn't properly activating: what are some probable causes?
2. Describe some "collision events" that occur in real-life games.
3. List the collision events that your game idea will need programmed, then sort them by priority for the game to work!

Week 7: Widget and HUD

1. What common factors do you see between games with lots of interaction with the HUD and Widgets?
2. In such a game with a complex HUD, would it be best to integrate the different HUD elements into one Widget, or create numerous separate Widgets to add to the screen? Why?
3. What Widgets will need to be displayed for your game, and which will need to be interactive (if any)?