Introverts are not disadvantaged in group-based active learning classrooms

K. M. Flanagan* – Instructor, University of Calgary, Department of Biological Sciences,

Calgary, AB CANADA, T2N 1N4

H. Addy – Teaching Professor, University of Calgary, Department of Biological Sciences,

Calgary, AB CANADA, T2N 1N4

*kmflanag@ucalgary.ca, p: 403.220.7644, Mailing address: Department of Biological Sciences, BI 266, 2500 University Dr N.W., Calgary, AB, CANADA, T2N 1N4

Abstract

Evidence of the effectiveness of active learning has resulted in a shift in post-secondary classrooms towards student-centred teaching, often relying heavily on peer-to-peer interactions. While the overall benefit of these teaching methods is established, it remains unclear whether all sub-populations of students benefit similarly. Given the intensive peer-to-peer nature of group-based active-learning approaches, we questioned whether introverted students are at a disadvantage in these active-learning classrooms. To explore this question, we examined how course performance, peer-evaluation scores, and affective measures of course experience differ for introverts, ambiverts, and extroverts in two active-learning classrooms over two years. Our results show no disadvantage in any of the measures explored for introverted students; introvert, ambivert and extrovert students performed equally well, received comparable ratings by peers, and reported similar affective attitudes towards our courses. Despite the intensive use of peer discussion, with permanent groups that were highly integrated into each class, our group-based, active-learning classrooms did not favor extroverts nor disadvantage introverts. We explore reasons why our results differ from other studies that find introverted students enjoy group work less.

Introduction

Overwhelming evidence of the benefits of active learning across disciplines and contexts in higher education has been well established (Freeman et al., 2014; Hake, 1998). Active learning is a broad term capturing any teaching method that involves students in their learning by doing more than listening and taking notes (Bonwell & Eison, 1991; Felder & Brent, 2009). In active-learning classrooms, students are often expected to construct their knowledge through discussion and debate with peers (Crouch & Mazur, 2001). While interactions with peers are often a crucial component of active learning, the extent of these interactions can vary from a quick 'pair-share' with a neighbour, to working extensively in permanent student groups for a semester. Evidence of the benefits of active learning have resulted in a widespread movement towards incorporating active learning, including peer-to-peer learning, into post-secondary classrooms.

While the importance of active learning is well known, it is not clear whether certain types of students are privileged over others in active learning classrooms, particularly given the importance of peer-to-peer interactions. Most studies examining the impact of active learning measure average learning gains, or average increases in class performance measures. With an average increase, some groups of students might experience smaller increases than others, placing them at a disadvantage. Alternatively, it is possible that certain students may have reduced performance, but the success of other students overwhelms this response when averaged. This disparity may be particularly true if the decrease in performance occurs for those students who are in the minority. For example, Eddy et al. (2015) examined the roles of gender and race/ethnicity/nationality in the preferred roles of students in peer discussions in active-learning classrooms. Both gender and race/ethnicity/nationality impacted the preferred roles students selected in peer discussions, with females preferring not to take leadership roles in groups and minorities preferring to be listeners in group discussions. Additionally, increased focus on working with peers can be challenging for LGBTQIA students, for whom the active-learning classroom may not be a welcoming or accepting place (Cooper & Brownell, 2016). Now that we understand the overall positive impact of active-learning approaches, it is important to explore the nuances of learning within these contexts to ensure that some students are not being disadvantaged while other students thrive. In our own teaching, we have questioned whether introverted students may be at a disadvantage in active, peer-discussion-based learning environments. Like many other post-secondary instructors, we have both recently "flipped" our classes away from a lecturing-intensive approach to an active-learning approach in which students spend much of their class time working in permanent small groups. We wondered whether this change would disadvantage

introverts relative to extroverts. Introverts tend to prefer less social stimulation, require more time to think and reflect before contributing ideas, and would often prefer to write rather than speak (Cain, 2012; Condon & Ruth-Sahd, 2013; Davidson, Gillies, & Pelletier, 2015). Introversion is not the same as shyness or social anxiety, and it is important to understand that introverts are not necessarily unwilling to talk, but typically need more time to process the information and formulate what they want to say. Extroverts, on the other hand, are characteristically comfortable with sharing their thinking spontaneously and making quick decisions. Given a choice, extroverts usually prefer speaking with others rather than working independently (Cain, 2012, Condon and Ruth-Sahd, 2013), seemingly making extroverts suitably "adapted" to the active-learning classroom and potentially placing introverts at a disadvantage. Certainly, recent coverage in mainstream media reveals a concern around introverts in classrooms. Articles such as, [Why Introverts Shouldn't be Forced to Talk in Class](#), and [Participation Penalizes Quiet Learners](#), express the concern that the increased use of peer discussion may be placing introverts at a disadvantage. There is evidence that introverts may find group work less enjoyable and may feel isolated and/or participate less (Hennessy & Evans, 2006). Introverts may have more negative views of group work (Walker, 2006), and may prefer more independent work over interactive teaching methods (Chamorro-Premuzic, Furnham, & Lewis, 2007; Pawlowska, Westerman, Bergman, & Huelsman, 2014). However, it is less clear whether introverts' performance in active group-based courses is negatively (or less positively) impacted, or whether students perceive the contributions of introverted peers differently from those of their more-extroverted peers. In courses where peer evaluation is a component of the grading system, it is important to understand how introversion may influence the value that their peers may place on a student's contributions, to ensure that students do not "overvalue" contributions of extroverted students relative to introverted students. As with any approach to learning, we need to understand the impact of group-based active learning on diverse students within our classrooms, to ensure we are not under- nor over-privileging certain types of students.

In this study, we compared course performance, peer-evaluation scores, and affective attitudes of self-identified introverts, ambiverts (students in the middle of the introvert-extrovert continuum) and extroverts in two active-learning classrooms over two years. To measure affective attitudes towards experiences in our active learning classrooms, we used a validated survey tool (Experiences of Teaching and Learning Survey, Entwistle, Mccune, & Hounsell, 2002) at the end of the semester. This tool measures four factors: perceived peer support; engagement with course material; and perceived learning gains in ability to work with other students, and ability to communicate knowledge and ideas effectively.

Methods
Our courses

We conducted this research in two courses, Quantitative Biology and Biology of Fungi, in 2015 and 2016 at a research-intensive Canadian university. Quantitative Biology I is an upper-level course aimed at introducing undergraduate biology students to statistics. The topics of the course include: sampling, statistical populations, statistical inference, t-tests, ANOVA, Linear Regression, Analysis of Frequencies, Permutation tests, and Transformations. In addition to three 50-minute classes a week, students attend weekly three-hour computer-based Labs where they learn how to conduct statistical tests in the statistical software R. In 2015 and 2016, there were 129 and 168 students enrolled in this course, respectively. Between 26-27% of students were in their second year in 2015/2016, 43-46% of students are in their third year, 20-30% are in their fourth year or above. This course is a pre-requisite for less than half of the class; others take this course as an elective.

Biology of Fungi is a third-year course that provides an introduction and overview of fungal biology, a topic that most students have not learned about prior to this course. The course deals with fungal diversity, evolution and ecology, and ends with a section on medical mycology. As for the Quantitative Biology course, there are three 50-minute classes each week and one three-hour lab. The course is an option for five of the six programs offered by the department but is not required by any program. The course typically fills to capacity (96 students) soon after registration opens. The majority of the students in the course are in their final year of studies.

Prior to the start of term, we send students a welcome email in which we outline the structure of the course and explain that they will be working in permanent groups of 5-6 students during class time. To help us form heterogeneous groups, we ask the students to complete a brief group-forming survey, with questions relating to previous course history, gender and year of program. We also ask to self-identify as an introvert, extrovert or ambivert and provide a link to a quick 'Introvert Test' on the Quiet website ([www.quietrev.com/the-introvert-test/)](http://www.quietrev.com/the-introvert-test/), with

the recommendation to take the quiz if they are unsure how to categorize themselves.

Once the groups are formed, our classes follow a format based on the Team-Based Learning approach developed by Michaelsen (2004). The courses are divided into modules, each of which begins with students preparing outside of class by completing assigned readings and videos. In the first class of each module, students write a quiz based on this background preparation first as individuals and then as a group. Using the results of the quiz, we follow with lectures for one or two classes, in which we clarify any points of confusion and provide any additional foundational knowledge necessary for the group assignments, which make up the rest of the module. The group assignments are designed to increase in complexity and require students to work together to apply the material in novel scenarios. Students work collaboratively during class time for more than 50% of classes. The module is wrapped up with a reflection/summary class and then the next module begins.

Course performance

We measured course performance as the student's final percentage grade, without the incorporation of the peer evaluation score. The final grades for each student were converted to a z-score to allow for meaningful comparison between courses and years.

Peer evaluation score

A student's mark in our courses is determined by both individual work on exams and assignments and group work on in-class assignments and quizzes. To promote accountability to the group, the group work component is weighted by a student's final peer evaluation score. Peer evaluations are completed using ITP Metrics (www.itpmetrics.com) mid-way through the semester and again at the end of the semester. ITP Metrics is a free, research-based online teamwork-assessment platform with a peer-feedback tool assessing individuals based on key teamwork competencies (O'Neill et al., 2018). The peer evaluation score is the student's average score (from all individuals in the group) divided by average score of all group members. The peer score is bounded at a minimum of 0.60 and a maximum of 1.05, and scores between 1.00 and 0.95 are rounded up to 1.00. Therefore, when the score falls below one, the student is assessed by the group as having done less than expected, if the peer score is equal to one, the student meets expectations, and above 1 (capped at 1.05), the student was assessed as having done more than expected. The score is not calculated as a zero-sum game, so that if one student does more than expected, that does not necessitate that another student has done

less than expected. The student's overall score on the final peer evaluation is applied as a multiplier for the total group work component of their grade. The group components of the course count for 11% of the Quantitative Biology course and between 15- 20% of the Biology of Fungi course.

Affective measures of course experiences

At the end of the term, students completed the Experiences of Teaching and Learning (ETL) Survey (Entwistle et al., 2002) electronically through SurveyMonkey. This survey was developed by the Enhancing Teaching-Learning Environments in Undergraduate Courses Project of the University of Edinburgh and has been validated for several student populations (Hounsell & Mccune, 2002), including Canadian students (Fall, 2012). We examined two Experiences of Teaching and Learning sub-scales that addressed student perceptions of a) Peer Support ("Support from other Students": items 21, 24 and 29 of the Perceptions of the Teaching-Learning Environment component) and, b) Engagement with the course material ("Interest, enjoyment and relevance": items 8, 11, 19, 22 and 26 of the Perceptions of the Teaching-Learning Environment component) (Table 1).

For all items, ratings were made on a 5-point Likert-type scale (agree = 5, agree somewhat = 4, unsure = 3, disagree somewhat = 2, disagree = 1). The scores on each response were summed within each subscale to produce subscale scores for each student out of 15 and 25 for Peer Support and Engagement, respectively (ETL user guide).

We also examined two individual measures on the Experiences of Teaching and Learning survey that explored the perceived learning gains on aspects associated with group work. Students responded to statements about how much they felt they gained from this course (on a scale of "a lot", "quite a lot", "unsure", "not much", "very little"), with respect to: "ability to work with other students", and "ability to communicate knowledge and ideas effectively".

Statistical analyses

All analyses were conducted in RStudio version 1.1.143 using the base, lme4 and Psyc packages. To examine whether (1) student performance in terms of the final grades (z-scores), (2) Peer Evaluation Score and (3) the affective measures (Engagement and Peer Support) differed for introverts, ambiverts or extroverts in our classes, we produced general linear models with predictor variables a) introversion b) course and c) year and all higher order interactions. If variables were non-normal, they were arc-sine transformed (because they are proportions). In some cases, this transformation did not completely fix the

Table 1. Experiences of Teaching and Learning (ETL) sub-scale items examined (Peer Support and Engagement), with the ETL item number and statements associated with each sub-scale. Peer support is a 3-item sub-scale with a maximum possible score of 15. Engagement is a 5-item sub-scale with a maximum possible score of 25.

Sub-scale item	ETL item number and statement
Peer support – Support from other students (3 item scale)	21. Students supported each other and tried to give help when it was needed
	24. Talking with other students helped me to develop my understanding
	29. I found I could generally work comfortably with the other students on this unit
Engagement – Interest, enjoyment and relevance (5 item scale)	8. I can imagine myself working in the subject area covered by this unit
	11. I could see the relevance of the most of what we were taught in this unit
	19. This unit encouraged me to relate what I learned o issues in the wider world
	22. I found most of what I learned in this course unit really interesting
	I enjoyed being involved in this course unit

non-normality. However, with sample sizes above 50, we suspect the non-normality is not impacting our statistical conclusions.

Student responses about how much they learned with respect to ability to work with others, and ability to communicate knowledge and ideas effectively, with only single item responses for each, meant the data could not be treated as a continuous numerical variable and therefore were analyzed using Contingency analysis for frequency data. We then tested whether the frequency of student responses to the statements differed for introverts, ambiverts and extroverts in a given course and year. A non-significant result ($p>0.05$) would indicate that introverts, ambiverts and extroverts are not responding significantly differently to this statement, whereas a significant result ($p<0.05$) would indicate differences in how the three groups of students responded.

Results

For two active-learning classrooms over two years, we collected measures of course performance, peer evaluation scores and affective measures of course experiences. We used general linear models and contingency analyses to explore whether self-identified introverts, ambiverts and extroverts differed significantly for any of these measures, with the aim of determining whether active-learning classrooms place introverted students at a disadvantage relative to their peers.

A total of 266 students participated in this study. The proportion of introverts in each class ranged from 29-69%, the proportion of ambiverts ranged from 33-59% and extroverts ranged from 12-29% (Table 2). To measure overall course performance, we examined the mean final grades without the incorporation of the peer score for introverts, ambiverts and extroverts. The final percentage grades were converted to z-scores for

Table 2. The number and percentage (brackets) of students who self-identified as Introverts, Ambiverts[*] or Extroverts in Quantitative Biology or Biology of Fungi in 2015 and 2016 (N=266).

*in Fall 2015, Biology of Fungi students were not given the option of ambiverts on the initial survey. NA indicates the absence of data

	2015		2016	
	Quantitative Biology	*Biology of Fungi*	*Quantiative Biology*	*Biology of Fungi*
Introverts	24 (29%)	37 (69%)	26 (32%)	18 (38%)
Ambiverts	49 (59%)	NA	28 (35%)	16 (33%)
Extroverts	10 (12%)	17 (31%)	27 (33%)	14 (29%)

Table 3. Mean Peer evaluation score, mean score for the Experiences of Teaching and Learning survey sub-scale for Peer Support, and Engagement. Means shown for Introverts, Ambiverts* and Extroverts in Quantitative Biology and

| | 2015 | | | | | |
| | Quantitative Biology | | | Biology of Fungi | | |
	Introverts	Ambiverts	Extroverts	Introverts	Ambiverts	Extroverts
Mean Peer evaluation score (max. score 1.05)	1.02	1.01	1.03	1.02	■	1.01
Mean Peer Support (max. score 15)	13.79	14.16	14.30	13.89	■	13.94
Mean Engagement (max. score 25)	19.88	19.06	21.30	20.86	■	21.65
	2016					
	Quantiative Biology			Biology of Fungi		
	Introverts	Ambiverts	Extroverts	Introverts	Ambiverts	Extroverts
Mean Peer evaluation score (max. score 1.05)	1.01	1.01	1.02	1.02	1.01	1.00
Mean Peer Support (max. score 15)	14.00	14.36	14.26	14.28	14.81	14.86
Mean Engagement (max. score 25)	20.85	21.21	19.56	21.56	21.94	22.43

Biology of Fungi in 2015 and 2016.*in Fall 2015, Biology of Fungi students were not given the option of ambiverts on the initial survey, blacked out area indicates the absence of data

meaningful comparison across courses and years. The mean final grade (z-score) was not significantly different for introverts, ambiverts and extroverts in either course in either year (Fig 1, GLM, F=0.4812, df= 10, 255, p=0.9015).

To determine if peers evaluate the contributions of introverted vs. extroverted students differently, we examined the final peer evaluation scores and compared these scores for students in both courses and year. The mean peer evaluation scores varied little between the groups, ranging from 1.00 -1.03 (Table 3). The peer evaluation scores were not

significantly different for the three groups of students across courses and years (GLM, F=0.9818, df=10,255, p=0.4597)

Mean Peer support scores from the Experiences of Teaching and Learning survey sub-scale were high, relative to the maximum score of 15. The scores ranged from 13.79 to 14.16 (Table 3). There was no significant difference between introverts, ambiverts or extroverts (GLM, F=1.026, df=10, 255, p=0.4218).

Mean Engagement scores from the Experiences of Teaching and Learning survey sub-scale ranged from 19.06 - 22.43 (Table 3). There was no significant
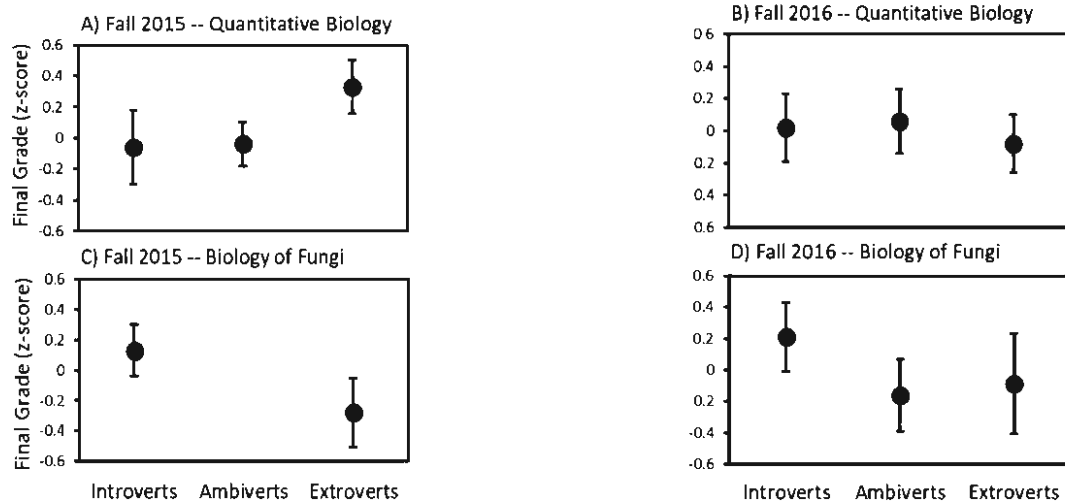

Figure 1. The mean final grade (percentage grade converted to a z-score) for Introverts, Ambiverts* and Extroverts in Quantitative Biology (panels A & B) and Biology of Fungi (panels C & D) in Fall 2015 (panels A & C) and Fall 2016 (panels B &D). Standard error of the mean bars shown. *in Fall 2015, Biology of Fungi students were not given the option of ambiverts on the initial survey, therefore no ambivert mean is shown in panel c

difference between introverts, ambiverts or extroverts (p=0.4821), but there were significant differences in engagement between the courses (p=0.0042) and years (0.0482). Engagement was higher in Biology of Fungi and went up between 2015 and 2016. There were no significant interactions between introversion, year and courses.

In evaluating the measures on the Experiences of Teaching and Learning survey that explored the perceived learning gains with respect to "ability to work with other students", and "ability to communicate knowledge and ideas effectively", most students responded as having learned "quite a lot" or "a lot" (Fig 2 & Fig 3). There was no significant
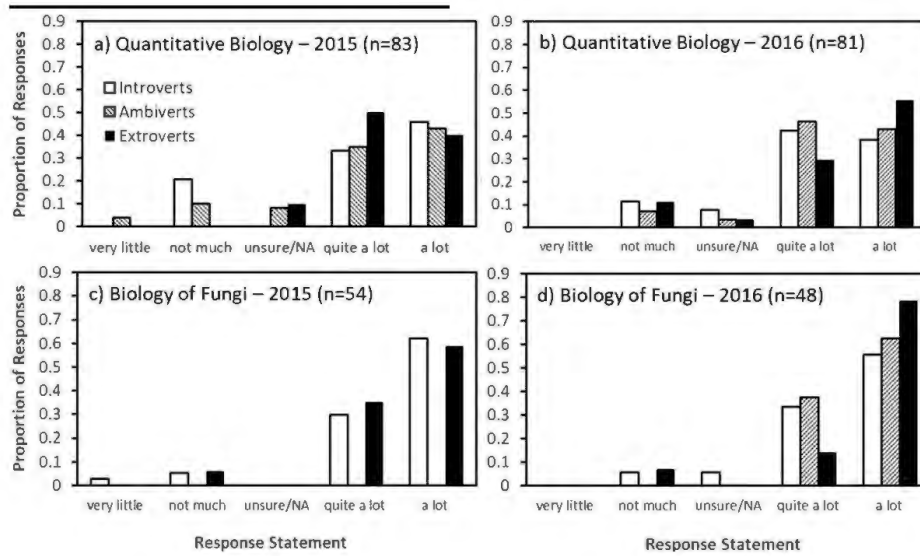
Figure 2. Proportion of student responses to the Experiences of Teaching and Learning survey item, how much did you learn in this course with respect to "ability to work with others". Reponses shown for Quantitative Biology (panels A & B) and Biology of Fungi (Panels C & D) in 2015 (panels A & C) and 2016 (panels B & D). Introverts = white bars, Ambiverts = cross-hatched bars, and Extroverts = black bars
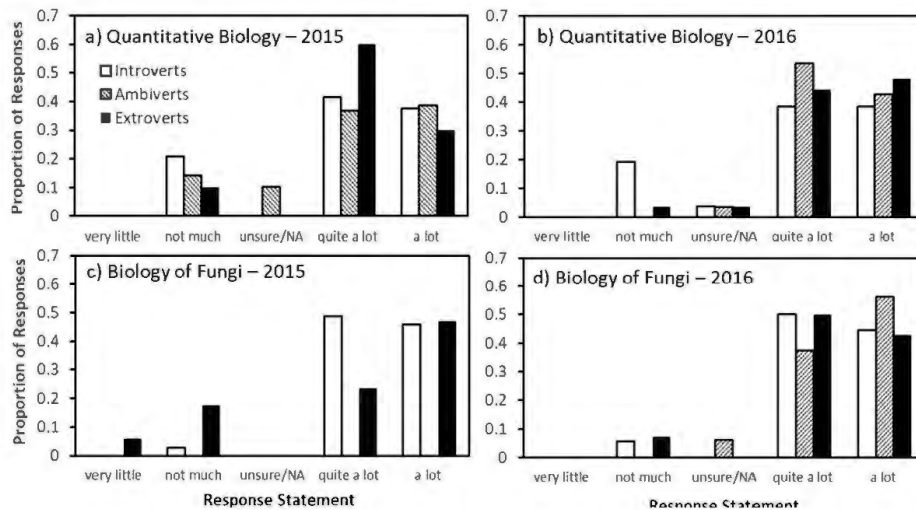
Figure 3. Proportion of student responses to the Experiences of Teaching and Learning survey item, how much did you learn in this course with respect to "ability to communicated knowledge and ideas effectively". Reponses shown for Quantitative Biology (panels A & B) and Biology of Fungi (Panels C & D) in 2015 (panels A & C) and 2016 (panels B & D). Introverts = white bars, Ambiverts = cross-hatched bars, and Extroverts = black bars.

difference in the proportion of student responses for introverts, ambiverts or extroverts for Quantitative Biology in Fall 2015 (p=0.5431) or Fall 2016 (p=0.9222). There were also no differences in Biology of Fungi in Fall 2015 (p= 0.934) or Fall 2016 (p= 0.6071).

Discussion

Our results show no disadvantage in any of the measures explored for introverted students in our active-learning classrooms. Introvert, ambivert, and extrovert students performed equally well in terms of final grades, received comparable peer evaluation scores, and reported similar affective attitudes towards our courses. Students reported high levels of both peer support and engagement with the course materials and these levels did not differ for introverted students. Additionally, reported learning gains in ability to communicate knowledge and understanding, and ability to work with others were not significantly different for introverts, ambiverts, and extroverts. Despite the intensive use of peer discussion, with permanent student groups that were highly integrated into all classes, our courses did not favor extroverted students nor disadvantage introverts. Our results contribute to the understanding of student experiences and performance in active-learning classrooms and provide evidence that active-

learning classrooms can be positive experiences for introverted students. We are both introverts and have both thought deeply about how we ourselves would feel entering the courses we have designed. We suspect our initial reaction to reading the course syllabus and arriving at class on the first day would be dread-filled anxiety. But what we witnessed, and documented in this research, was a very different experience than we anticipated for introverted students.

Our findings also differ from several studies showing that introverts have more negative experiences in courses relying heavily on peer interactions (Chamorro-Premuzic et al., 2007; Pawlowska et al., 2014; Persky, Henry, & Campbell, 2015; Walker, 2007; Webb, 1982). For example, Webb (1982) reported that introverted students were more likely to be ignored by group mates when they asked questions to clarify misunderstandings than were extroverted students, and not receiving answers was correlated with lower achievement on tests based on group work topics. In this course, students were assigned to a group of three based on alphabetical order, with adjustments made to group composition to avoid placing friends on the same team and to ensure that highest or lowest achieving students were not on

the same group. Walker (2007) specifically investigated whether introverts were at a disadvantage in post-secondary courses relying heavily on group work. Students were divided into groups of five or six students to complete a group research project; students were able to select their own group although some students asked the instructor to put them into groups. Introverted students reported having a more negative group work experience but there were no differences in grades between introverted and extroverted students. Similarly, Persky et al. (2015) reported that while extroverts and introverts had same final exam grade performance, introverts expressed a lower preference for team-based learning. In this study, students were divided into teams of six people, balanced for gender. In all of these studies, students worked in groups but the authors do not describe any specific steps taken to develop teamwork skills and does not appear that there was any intentional focus on team-building strengths. In contrast, our courses included approaches that we speculate facilitated a more-positive group-work experiences particularly for introverted students, as outlined below:

1. We target successful collaboration with peers as an important course outcome and work with students to intentionally develop these skills.

The ability to work successfully with peers is essential for our courses and in students' future careers (Kivunja, 2014) and we make this goal transparent for our students. While many instructors assume students will develop group work skills as they work together, we have found it important to allocate time, in and out of class, to build these skills. We incorporate into our curriculum readings on working successfully with peers (for example: https://www.nytimes.com/2016/02/28/magazine/what-google-learned-from-its-quest-to-build-the-perfect-team.html) and incorporate activities early in the term to help students recognize, value, and develop these skills. We build in time for students to discuss and explore what is working well in their groups, to set goals for how to work together and for themselves as group members, and to monitor these goals through the semester. At the end of the semester, we provide opportunities for reflection on group experiences, and time to celebrate the success of the groups. Throughout the semester, we also meet with groups or individuals who are struggling to discuss strategies for success in collaboration. Dedication of class time and course content to activities that help students work well with peers communicates the importance of group-work skills and gives students tools, resources, and support to develop these skills.

2. We discuss diverse ways individuals can contribute to peer groups and highlight the value of contributions other than talking

Given that peer evaluation is a contributor to student grades in our courses, we want to ensure that students recognize and value diverse ways in which individuals contribute to groups. One strategy we use is to provide distinct roles for students to take within a group during class time (note taker, time keeper, facilitator, etc.), which are rotated among group members during the term. Having a clearly defined task to perform for the group (e.g. keep track of time) can help students contribute to the group, when they might otherwise be unsure of how they can participate (Jacobs, 2014). Additionally, as part of discussions relating to peer evaluation, we emphasize that contributions will be different for different students, given diverse strengths and personalities within a group. We encourage students to recognize that participation does not equal how much someone talked during group discussion and to value contributions that may occur beyond peer discussions, such as organizing a Google Doc for shared notes, emailing meeting minutes, or organizing a time/space to study. For introverted students who may struggle to contribute during peer discussions in class, we offer these ideas as alternative ways they can contribute to the group. Class discussions about the diverse ways individuals can contribute to the group work are important for helping students recognize and value the contributions of others. We believe that all these measures are important to ensure that peer evaluation is not biased against introverted students.

3. We create the groups and aim for diversity in introversion in groups.

We create the student groups rather than let students form their own groups, to minimize anxiety around group formation. In a study where groups were formed by students, introverts' rating for "trusted each other", "enjoyed group work", and "felt valued" were significantly lower than ambiverts and extroverts (Walker, 2006). We also try to make the groups diverse in term of introversion - extroversion. While some studies have shown that groups that are more homogenous in term of introversion – extroversion have higher levels of satisfaction (French & Kottke, 2013), at least one study indicates that groups with an extroverted leader have increased group satisfaction and productivity (Rodríguez Montequín, Mesa Fernández, Balsera, & García Nieto, 2013). In the absence of a clear consensus about the composition of groups relative to introversion, we value creating groups that are diverse in terms of introversion-extroversion because such diversity is likely to be representative of the groups in which students will work during their careers.

Study Limitations

We recognize there are limitations to the generalizability of this research. Our study was conducted in only two classrooms (our own), with two instructors over two years at a single post-secondary institution. Our students self-identified on the introversion/ extroversion scale, potentially leading to some individuals incorrectly identifying themselves as an introvert or extrovert. Similar studies in different contexts need to be conducted to capture more broadly the range of experiences of introverts in active-learning classrooms. Future studies would be strengthened by incorporating follow-up interviews with students to explore which aspects of instruction were most important for student success and engagement with the course. Despite these limitations, our results indicate that, for many introverted students, the active-learning classroom was not a negative experience.

Conclusion

This study can be used to inform instructors who are concerned about the potential for active-learning techniques, particularly those that rely heavily on peer discussion, to negatively impact introverted students. We have shown, under the classroom conditions we describe, introverted students are not placed at a disadvantage in terms of performance, evaluation by peers, or in affective measures of course experience. When consideration is given to development of group work skills, recognition of diverse contributions to groups, and careful construction of groups, introverts can have positive experiences in active-learning classrooms that rely heavily on peer interactions.

References

BONWELL, C., AND EISON, J. 1991. Active Learning: creating excitement in the classroom. ASHE-ERIC Higher Education Report. https://doi.org/ED340272

CAIN, S. 2012. Quiet: The power of introverts in a world that can't stop talking. New York: Crown Publishers. https://doi.org/10.1016/j.jaac.2014.04.007

CHAMORRO-PREMUZIC, T., FURNHAM, A., AND LEWIS, M. 2007. Personality and approaches to learning predict preference for different teaching methods. Learn. Individ. Differ. 17(3): 241–250.

CONDON, M., AND RUTH-SAHD, L. 2013. Responding to introverted and shy students: Best practice guidelines for educators and advisors. Open J. Nurs. 3(7): 503–515.

COOPER, K. M., AND BROWNELL, S. E. 2016. Coming out in class: Challenges and benefits of active learning in a biology classroom for LGBTQIA students. CBE Life Sci. Educ. 15(3): 1–19.

CROUCH, C. H., AND MAZUR, E. 2001. Peer Instruction: Ten years of experience and results. Am. J. Phys. 69(9): 970–977.

DAVIDSON, B., GILLIES, R. A., AND PELLETIER, A. L. 2015. Introversion and Medical Student Education: Challenges for Both Students and Educators. Teach. Learn. Med. 27(1): 99–104.

EDDY, S. L., BROWNELL, S. E., THUMMAPHAN, P., LAN, M. C., AND WENDEROTH, M. P. 2015. Caution, student experience may vary: Social identities impact a student's experience in peer discussions. CBE Life Sci. Educ. 14(4): 1–17.

ENTWISTLE, N., MCCUNE, V., AND HOUNSELL, J. 2002. Teaching-Learning Environments : Concepts, Measures and Preliminary Findings. Occasional Report 1, ETL Project, Universities of Edinburgh, Coventry and Durham, Retrieved from: http://www.ed.ac.uk/etl

FALL, U. L. 2012. Confirmatory Factor Analysis of the Short Revised Experiences of Teaching and Learning Questionnaire (SR-ETL-Q): Examining the Internal Structure within a Canadian Undergraduate Population. Thesis Master of Education, University of Alberta.

FELDER, R., AND BRENT, R. 2009. Active Learning: An Introduction. ASQ Higher Education Brief 2(4) https://doi.org/10.1007/978-1-4419-9863-7_605

FREEMAN, S., EDDY, S. L., MCDONOUGH, M., SMITH, M. K., OKOROAFOR, N., JORDT, H., AND WENDEROTH, M. P. 2014. Active learning increases student performance in science, engineering, and mathematics. PNAS 111(23): 8410–8415.

FRENCH, K. A., AND KOTTKE, J. L. 2013. Teamwork satisfaction: Exploring the multilevel interaction of teamwork interest and group extraversion. Active Learn. High. Educ. 14(3): 189–200.

HAKE, R. R. 1998. Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. Am. J. Phys. 66(1): 64–74.

HENNESSY, D., AND EVANS, R. 2006. Small-group learning in the community college classroom. ProQuest Education Journal 12(1): 93–110.

HOUNSELL, D., AND MCCUNE, V. 2002. Teaching-Learning Environments : Concepts, Measures and Preliminary Findings. Occasional Report 2, ETL Project, Universities of Edinburgh, Coventry and Durham

JACOBS, G. 2014. Introverts Can Succeed With Cooperative Learning. Parole 4(1): 83–93.

KIVUNJA, C. 2014. Do You Want Your Students to Be Job-Ready with 21st Century Skills? Change Pedagogies: A Pedagogical Paradigm Shift from Vygotskyian Social Constructivism to Critical Thinking, Problem Solving and Siemens' Digital Connectivism. Int. J. High. Educ. 3(3): 81–91.

MICHAELSEN, L., BAUMAN KNIGHT, A., AND FINK, L. D. 2004. Team-Based Learning A Transformative Use of Small Groups in College Teaching. Stylus Publishing.

O'NEILL, T. A., DEACON, A., GIBBARD, K., LARSON, N., HOFFART, G., SMITH, J., AND DONIA, M. 2018. Team dynamics feedback for post-secondary student learning teams. Assessment and Evaluation in Higher Education 43(4): 571-585.

PAWLOWSKA, D. K., WESTERMAN, J. W., BERGMAN, S. M., AND HUELSMAN, T. J. 2014. Student personality, classroom environment, and student outcomes: A person-environment fit analysis. Learning and Individual Differences 36:180–193.

PERSKY, A. M., HENRY, T., AND CAMPBELL, A. 2015. An Exploratory Analysis of Personality, Attitudes, and Study Skills on the Study Skills on the Learning Curve within a Team-based Learning Environment. Am. J. Pharm. Educ. 79(2): 1-11.

RODRÍGUEZ MONTEQUÍN, V., MESA FERNÁNDEZ, J. M., BALSERA, J. V., AND GARCÍA NIETO, A. 2013. Using MBTI for the success assessment of engineering teams in project-based learning. Int. J. Technol. Des. Educ. 23(4): 1127–1146.

WALKER, A. (2007). Group- work- in- higher-education:-- are introverted- students- disadvantaged? Psychol. Learn. Teach. 6(1): 20–25.

WEBB, N. M. 1982. Group composition, group interaction, and achievement in cooperative small groups. J. Educ. Psychol. 74(4): 475–484.