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The Flipped Classroom: A Means to Reduce Cheating?

Dr. Alison B. Hoxie, University of Minnesota Duluth

Dr. Alison B. Hoxie is an Assistant Professor in the Mechanical and Industrial Engineering Department at the University of Minnesota Duluth. Her education includes a B.A. in Natural Science from the College of Saint Benedict (1999), a B.S.M.E (2001) and a Ph.D. (2007) from the University of Minnesota Twin Cities. She has held positions as a consulting engineering in power and energy sector, and as an Instructor at the University of Utah. Her current research focuses on cost effective methods for efficient utilization of biomass-derived oils in combustion applications.

Dr. Thomas Shepard, University of St. Thomas
Dr. Robert Feyen, University of Minnesota Duluth

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Abstract

The flipped classroom is not a new concept in teaching nor is it hard to obtain successful stories of professors' experiences with this type of pedagogy. The account presented here of a junior level fluid mechanics course in a mechanical engineering department deviates from the traditional by focusing on an outcome of the flipped classroom that may have previously been overlooked: the discouragement of cheating. This paper discusses the relationship between the method of course material delivery and the consequential impact on overall student performance with an emphasis on cheating. Specifically, the questions addressed in this research are: In a time of rampant academic misconduct, does the flipped classroom structure inhibit students' ability to cheat? Does increasing active learning within the format of the flipped classroom further increase the students' accountability for the course material? Test scores collected in the flipped classroom and a more traditional lecture format are presented for comparison. Additionally, student surveys focused on academic misconduct under different delivery methods are summarized and the outcomes of student perception of the inverted delivery method presented. Suggestions to faculty seeking to try this instructional method are also given to help smooth the transition from traditional methods.

Introduction

In the traditional undergraduate engineering classroom one will typically find an instructor presenting new material via lectures, which may also include demonstrations, example problems, and other active learning techniques. An increasingly popular course structure, the flipped classroom, aims to maximize the amount of in-class time dedicated to active learning. It is noted that the flipped classroom is also known as an inverted classroom[1-2], an inside-out classroom[3], or this pedagogical approach can be combined with more traditional in-class lectures in numerous varieties of a hybrid approach. As aptly stated by Lage et al.[1], in the flipped classroom events that would typically occur during class time are moved to take place outside of class and vice versa. In order to accommodate the increased class time for student-centered activities in a flipped classroom the traditional in-class lecture component is minimized or removed altogether. Students then receive lecture material typically through computer-based videos and instructional activities to be completed prior to attending class. A review of the literature reveals that instructors are utilizing the flipped classroom in a variety of undergraduate engineering courses from first-year[4] to senior year[5] and even programming[2] and mathematics[6] courses.

Compelling evidence for the efficacy of this pedagogical approach comes from research that concludes that watching video lectures can be as effective at conveying information to a student as having them sit through a lecture in-person[7-9]. As described by Bishop and Verleger[10] in their comprehensive survey of published research on the flipped classroom, students are more likely to watch assigned videos outside of class that results in better preparation than assigned textbook readings[11]. If the sage wisdom and course content within an instructor's lecture can be effectively delivered outside of class, it then follows that more in-class time is available for the instructor to act as a guide during student-centered learning activities that enhance the quality of the classroom experience and increase student learning. The various active learning methods that can be more frequently utilized include problem-based learning, peer-assisted learning, cooperative learning, collaborative learning and peer tutoring[10]. Thus, a flipped classroom has the potential to not only improve student learning outside of class, but within the classroom as well.

The flipped classroom represents a significant departure from the typical undergraduate engineering student experience, one which has the potential for a variety of student impacts. One such impact that has not been examined in the literature, to the authors' best knowledge, is how the flipped classroom affects academic misconduct. It has been reported that 74% of undergraduate engineering students admit to committing some form of cheating[12], a percentage which is second only to business majors. Passow et al.[13] report that cheating is more likely on lower stakes assessments, such as homework, than higher stakes assessments. This is supported by results showing that 90-95% of engineering students are able to find access to textbook problem solutions not distributed by the instructor[14-15]. A flipped classroom structure that moves lower stake assessments into the classroom and under the supervision of the instructor could present one means of reducing misconduct.

The topic of how to prevent academic dishonesty from occurring has been examined by a number of studies. When students feel that they are receiving poor instruction with confusing lectures, material whose usefulness is not recognized, an unreasonable workload and see the instructor as indifferent to student learning they are more likely to rationalize misconduct. This suggests that increased instructional quality may result in lower rates of cheating[16-17]. When an instructor makes clear the relevance of the material and learning objectives research shows that cheating is reduced[18]. These actions may ultimately increase intrinsic student motivation for learning the material that has been related to a lower propensity for cheating[19]. In a flipped classroom, it is possible that the additional in-class activities will aid in clarifying relevance, while recorded lectures allow a student to re-watch sections which were confusing at first to increase their understanding which would suggest lower motivation for cheating.

The aim of the current study is to examine how the flipped classroom organization affects academic misconduct as compared to a traditional classroom. The hypothesis under consideration is that flipping the classroom will inhibit opportunities and temptation for cheating among students that may result in less cheating.

Flipped versus Traditional course delivery

Traditional Class: Structure

For this study, a traditional class is considered to be on that delivers course content primarily through lecturing. Traditional classes meet three times a week for 50 minutes at a time. Homework is assigned and turned in once a week and typically 2-3 midterms with a comprehensive final exam make up the main assessment for the course.

Flipped Class: Structure

Two sections (18-20 students each) of a junior level Fluid Mechanics class in a mechanical engineering department were flipped in order to increase student engagement. The class was traditionally taught on a Monday, Wednesday, Friday schedule for fifty minutes each day but was moved to Tuesday and Thursday and the class time extended to 75 minutes. The longer duration allowed for in-class activities and projects to be part of the class time.

Moodle, an online delivery system, similar to Blackboard, developed through the University of Minnesota system, was used as the primary delivery method for online content in the course. Electronic learning components of the class were delivered via Moodle through the use of learning modules. The learning modules provided the fundamental information needed by the students to be ready to tackle the homework problems in class. The Moodle site was also used to indicate which problems would be discussed during class time and due by the beginning of the next time the group met. Class time was always started with a 5-10 minute recap of the important points from the learning modules. This short lecture allowed the instructor to add some additional information or nuances that were not covered in enough detail in the online content. This was also a time where students had the opportunity to ask any questions they might have had about the material. After the short lecture, students would begin to work on the homework problems of the day. At least once a week an in-class activity was also incorporated into class time. The activities took about 10-15 minutes to complete and groups would cycle through the activity while continuing to work on homework. Group projects reinforced key equations that were learned throughout the semester: the Bernoulli equation, Linear Momentum equation, Bernoulli with losses, and a final project was given to include pump curves. Other forms of assessment included two midterm exams and a final exam.

In-class homework consisted of problems taken from the course textbook, 'Fundamentals of Fluid Mechanics' by Munson, Okiishi, Huebsch, and Rothmayer. Homework was assigned to be due at the next class period; this resulted in two shortened homework assignments per week. Two to three problems assigned on Tuesday were due on Thursday and three to four problems assigned on Thursday were due the following Tuesday. Solutions were posted to Moodle after grading was complete.

In-class exercises consisted of activities that could be completed as a small portion of the class. These activities were designed to demonstrate the concepts the students were currently learning in the online content as well as provide an environment to see concepts from the homework. The activities included:

- Measuring density with hydrometers.
- Exploring Pascal's principle.
- Using the Ideal Gas Law to calculate the ignition temperature in a compression igniter.
- Measuring pressure in a vessel with a manometer.
- Determining forces on submerged planes.
- Measuring buoyancy.
- Measuring flowrate using orifice and venturi meters.
- Measuring drag of airfoils and golf balls.

In-class projects were designed using the Water & Air Kits by Thames and Kosmos, shown in Figure 1. Students were asked to build a creation that could be modeled using the equations they had learned so far in the course and could also be measured in order to validate the model. As new equations were learned, the models became increasingly sophisticated. The first project was built after learning the Bernoulli equation. Subsequent projects occurred after the linear momentum equation, angular momentum equation and modified Bernoulli equation were introduced. For each project they were able to modify or build a new device. The final class projects involved piping systems using SharkBite® fittings. The students analyzed the piping systems they built and found operating points for their piping systems for one of the three pumps available in the class.

Figure 1: Air and Water Kit by Thames and Kosmos.

Online learning modules were created with the goal of increasing the active participation of students during the traditional lecture portion of the class. The idea of a flipped classroom is often accompanied with the notion that students watch video lectures at home. In the class considered here, lecture content was still a part of the learning module, however, the students prior knowledge was also taken into consideration. Modules often began with a presentation of an interesting phenomena aimed at increasing motivation and excitement for the content to be learned. These phenomena varied from sinking cups with entrapped air to glass beakers of burning fuel to people running on corn starch-water mixtures. After the phenomena was presented, an essay question followed asking the student to explain why or how the phenomena occurred. Next, questions on basic concepts were asked in order to gauge the current level of student understanding. If the student did not get all of the questions correct on the first try, the learning module sent them to a video that provided the fundamentals of the concepts they needed to understand. If they already understood the content and answered the questions correctly, they were passed along to the next topic. The learning modules covered the fundamental content the student needed for the course but were grouped around understanding the phenomena presented in the beginning of the learning module. Often the modules would end with an essay where students were asked to explain their new understanding of the phenomena; the essay also provided a place for students to ask questions about things they still did not understand. The instructor read the essays prior to the next class. Feedback was provided by the instructor for each essay, and common misunderstandings were addressed at the beginning of the next class. An example of the path a learning module might take is shown in Figure 2.

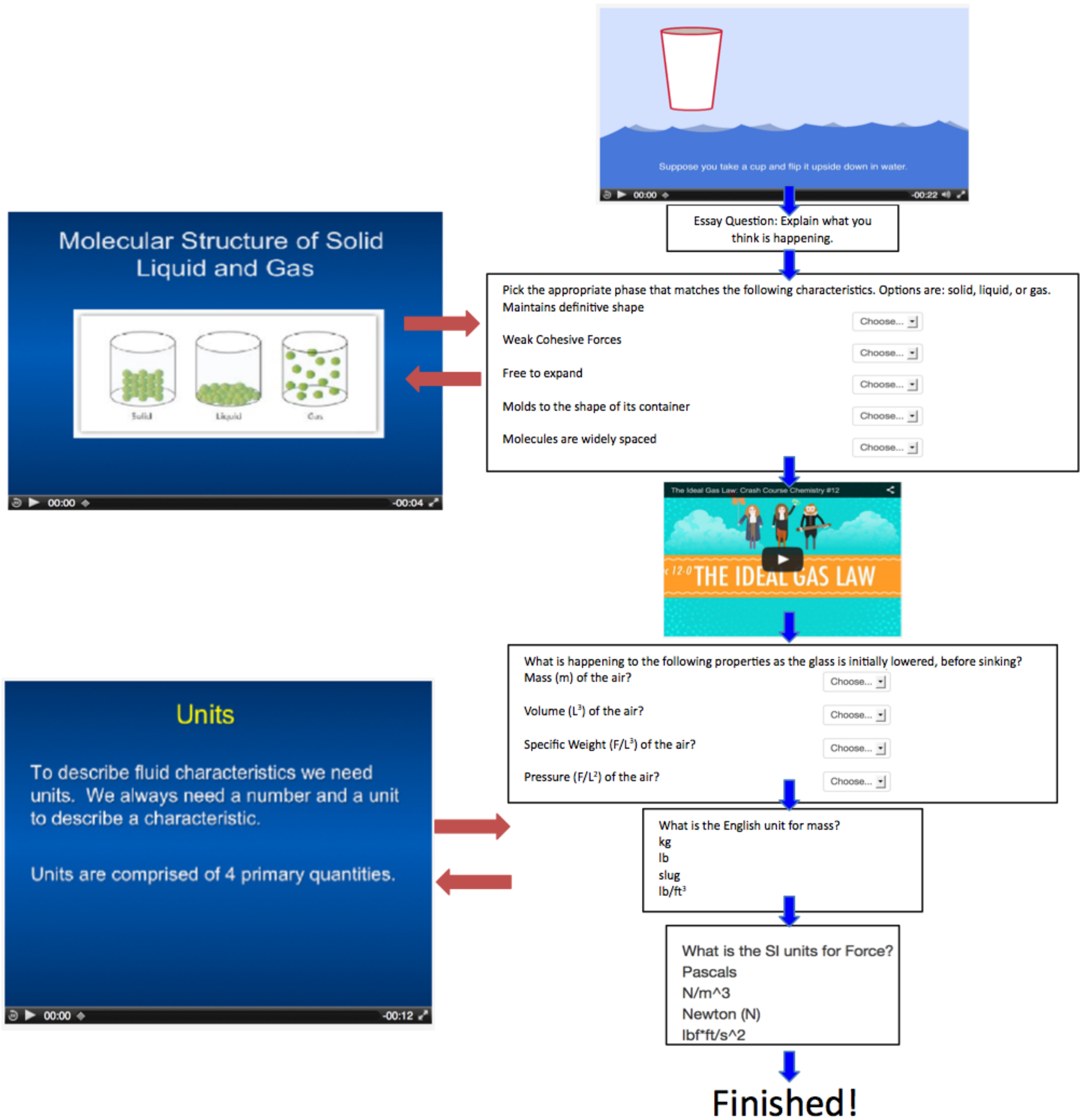


Figure 2: An example of the learning modules that comprised the online learning portion. Blue arrows indicate the path of the learning module. The red arrows indicate the additional lecture material provided if incorrect answers were given to the questions.

Comparison of flipped vs. traditional course outcomes

The midterms and final exam problems were taken from another instructor's bank of exams. This was done as a check to make sure the students were still learning the material needed to meet the learning objectives of the course. For one of the midterm exams, a post-hoc comparison was made between a previous lecture-based Fluid Mechanics class and the two sections of flipped Fluid Mechanics class reported on herein. In this comparison, two of the three problems given were the same for all three classes. The third problem was very similar and tested the same concepts. However, because this study was post-hoc only total tests scores were available for comparison and represent a limitation of this comparison. Figure 3 provides the exam question that differed between the exams. Test scores collected in the flipped classroom and the more traditional lecture format were compared; the results are shown in Table 1.

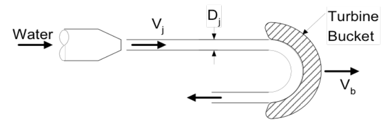
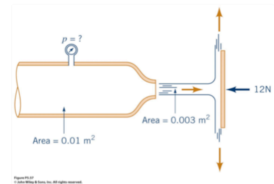
Lecture-Based Fluid Mechanics Exam Question	1. A water jet with a velocity of V_j = 30 m/s and a diameter of D_j = 10 cm drives a 180 degree impulse turbine to the right as shown in the figure below. The turbine bucket is moving to the right at V_b = 10 m/s. Assuming that the flow is steady and that the jet area remains constant as the water flows over the bucket, determine the following: (a) (20 points) Find the net force, in Newtons, that is imparted to the bucket. (b) (10 points) Find the power (in kW) that is imparted to the bucket. 
Flipped-Based Fluid Mechanics Exam Question	1. (30 pts) Air flows into the atmosphere from a nozzle and strikes a vertical plate as shown in the figure below. A horizontal force of 12 N is required to hold the plate in place. Determine the reading on the pressure gauge. Assume the flow to be incompressible and frictionless. 

Figure 3: Comparison of differing exam question in post-hoc comparison.

Both of the sections under the flipped classroom format had higher average test scores and smaller standard deviations as compared to the lecture based format. This result is in agreement with previously reported improvement in outcomes from implementing active learning strategies into a fluid mechanics course[20]. Most notably, however, was that the low score in both flipped sections was much higher than that of the traditional lecture format. One of the reasons that has been attributed to the increased student performance is that students learn better and retain material longer when they are actively engaged in their learning[21].

Table 1: Midterm scores for the flipped format and traditional lecture format.

Exam 1	Flipped Section 1	Flipped Section 2	Traditional Lecture
Average	86.4	85.7	73.5
High	100	99	91
LOW	61	71	47
STDEV	9.1	8.4	12.9

Another reason, especially regarding the structure of the flipped course discussed in this paper, is that students are held accountable for all aspects of their learning. Under the traditional lecture format, the professor controls the information being delivered to the students but has no control on whether they are listening or actually learning the material. In the flipped classroom setting, the learning modules are designed toward a more active engagement with the lecture videos by requiring students to complete questions and essays to arrive at the knowledge needed to understand different phenomena. This shifts the accountability for learning and understanding from the professor to the student.

Additionally, with the traditional format students often work alone, at home on their homework. If they get stuck or don't understand the material the temptation to use the web or solution manual is very strong. Especially with how readily available the solutions have become. Under the structure of the flipped classroom, the students work on homework in class, where the instructor and TA can observe their progress and help answer questions in real-time. Also, smaller and more frequent homework assignments do not allow for students to procrastinate as much, thus preventing a potentially greater temptation to cheat in order to finish a long assignment right before it is due. From the experiences of the authors, students that regularly use the solutions manual to do their homework are easy to spot under the flipped format. This was true for the flipped classroom course considered in this research. In one particular case, a student was routinely observed to be either on their phone or talking with other students instead of working on homework in class. After the first midterm, a quick glance at the student's midterm grade compared to their homework grade provided a clear indication that the student was not completing the homework assignments on his or her own. Because cheating is easier to spot, it is easier to address and prevent students from continuing the behavior.

Finally, it is the assertion of these authors that a contributing factor to the improved performance is partially due to a decrease in cheating on homework. In order to determine whether the tendency to cheat was reduced due to the change in instruction format a survey was given to a group of students, in which the majority had taken their fluid mechanics course under the flipped format. The details of the survey and the results are reported on in the following paragraphs.

Student Survey

Methodology

Subjects: All students present in an advanced Mechanical Engineering class (Heat and Mass Transfer) were asked to complete a survey voluntarily during the last 20 minutes of a class period. This class was chosen since enrolled students would have already taken 4 specific Mechanical Engineering classes: dynamics, material science, thermodynamics, and fluid mechanics. Observation indicated that the class consisted primarily of college-age males with only two or three exceptions in terms of each age and gender. The survey was completed by 45 students.

Survey tool: The paper-based survey was designed to elicit opinions from students about the delivery of material, effectiveness of learning and academic integrity (i.e., cheating) in the four classes listed above. No personal or demographic data was collected, other than an item requesting the term in which a specific class was taken. On average, the survey took 10 minutes to complete; an example is provided in Appendix A.

The survey consisted of four sections – one for each class – and the items in each section were identical. Each section consisted of a single page with print on both sides. The front side consisted of six (6) Likert-scale rating items, a blank for the term in which the course was taken and a filtering question regarding cheating incidents. Students who reported a cheating incident were asked to complete the back of the page; students who did not were directed to skip to the next page (section).

The back side of a page presented open-ended short answer items regarding the incidents reported: the number of students involved, type of assessment involved (homework, test or other), source of answers for the cheating incident (e.g., solution manual, other student) and opinions positing why the students involved cheated and if cheating bothered the respondent.

Protocol: With 20 minutes remaining in the designated class, the course instructor turned the class over to the survey administrator. This person provided a brief introduction to the purpose of the research, described specific details about the survey (e.g., time to complete, anonymity, expected length for open-ended questions and contact information), presented the consent process and asked if anyone had any questions. Students were then given the choice to complete the survey voluntarily or opt out and leave without penalty. Once the surveys were distributed and initial questions addressed, the administrator stayed in the back of the classroom to answer any questions. Completed surveys were left on a chair in another part of the room to ensure anonymity.

Survey Analysis

The first three classes in the survey had been taught in a traditional lecture format; the last class (Fluid Dynamics) had been taught in a previous semester using the flipped format. 29 of the 45 respondents had taken the latter class during the semester in which the course format was flipped; survey data from the remaining 16 respondents were not included in the comparative analysis.

Likert scale ratings: For each Likert scale item, respondents used a 5-point scale (1 = strongly disagree, 2 = disagree; 3 = neutral; 4 = agree; and 5 = strongly agree). During analysis, the item ratings were rescaled to range from (-2) to 2 and then assessed using a two-tailed t-test to determine if the mean was statistically significant (p-value < 0.05) from a neutral response For statistically significant items, a positive mean indicated agreement with the item; negative indicated disagreement (Table 2). Notably, the only items found to have neutral responses were associated with the Dynamics (traditional format) class.

The mean values for the flipped Fluid Mechanics course were rated more highly for all the aspects of a class that one would like to see in the structure of a class, as compared to the other three traditionally taught courses. These values fell between ‘strongly agree’ and ‘agree’ for the effectiveness of the course to help them learn and understand the material. Students were interested in the material and they enjoyed the course. The question of whether the format encourage cheating, elicited a more strongly negative response for the flipped class compared to the other three traditionally taught courses.

Another important consideration is whether the strength of agreement with that item differed between the classes in a statistically meaningful way. Pairwise comparisons between an item's ratings in two classes were carried out using paired t-tests for each item across all combination of classes. With only two exceptions, the flipped course yielded statistically stronger opinions on all items compared to its traditional counterparts (p-value = 0.00).

Table 2: Individual Likert-scale rating items for each course

	Material Science			***Thermodynamics***		
Items	**Mean**	**Std Dev**	**p-value**	**Mean**	**Std Dev**	**p-value**
1. The course was effective in helping me learn the material presented.	0.67	0.84	0.00	0.80	0.61	0.00
2. The course was effective in helping me to understand the material.	0.60	0.86	0.00	0.80	0.71	0.00
3. The course format/delivery method encouraged cheating.	-1.13	0.73	0.00	-0.57	1.01	0.01
4. I enjoyed the course.	0.37	0.89	0.03	0.50	0.78	0.00
5. I was interested in the material presented.	0.80	0.81	0.00	1.07	0.78	0.00
6. It would bother me if other student(s) cheated during this course.	0.57	1.04	0.01	0.63	1.13	0.01

	Dynamics			Fluid Mechanics		
Items	Mean	Std Dev	p-value	Mean	Std Dev	p-value
1. The course was effective in helping me learn the material presented.	-0.07	1.07	0.73	1.69	0.47	0.00
2. The course was effective in helping me to understand the material.	0.03	1.24	0.88	1.69	0.47	0.00
3. The course format/delivery method encouraged cheating.	-0.59	1.12	0.01	-1.38	0.82	0.00
4. I enjoyed the course.	0.28	1.13	0.21	1.72	0.45	0.00
5. I was interested in the material presented.	0.52	0.91	0.01	1.66	0.48	0.00
6. It would bother me if other student(s) cheated during this course.	0.17	1.23	0.46	0.90	1.14	0.00

With respect to the exceptions, the flipped course did not yield a statistically different response when compared to Material Science and Thermodynamics in terms of students being bothered by cheating; in each class, students reported being bothered to roughly the same degree (p-value = 0.25 for Material Science and p-value = 0.38 for Thermodynamics) . On the other hand, students in Dynamics appear ambivalent about any cheating (p-value = 0.02). The other exception was between the flipped course and Material Science – students indicated the delivery methods in both courses to be similar in terms of discouraging cheating (p-value = 0.23). However, as compared to Thermodynamics and Dynamics, students considered the flipped format to deter cheating to a statistically higher degree.

Cheating incidents: 12 of the 29 respondents analyzed did not report any cheating incidents. Of the remaining 17 respondents, 8 reported being aware of incidents of cheating in only one class and 9 reported cheating in 2 or more classes. Only one student reported observing cheating on an exam and the student reported this for all four courses ("students sitting close together and looking at each other's exams"). All other incidents related to homework and consisted of either copying work from another student or obtaining solutions from either a solution manual or an internet source. Course format did not appear to influence the number of observed cheating incidents. The results show 33% of students reported observing cheating in the flipped course; cheating was reported by 14 to 45% of the students in the other three traditional format courses. Interestingly, of the 8 students in the Fluid Mechanics class that indicated they observed cheating in the class, 6 of them indicated a disagree or strongly disagree to the question on the survey about course format encouraging cheating. And those same students indicated that the reason why cheating occurred was mainly to further understand the material. Also interestingly, reviewing the 16 respondents who were not included in the analysis because they took Fluid Mechanics as a traditional course, 5 reported cheating – approximately the same percentage (31%) as the flipped course. However, most of the comments indicated that cheating occurred because of poor instruction from the professor and therefore a lack of knowledge on how to do the homework problems.

Survey limitations: Because the survey was conducted to investigate a hypothesis posed some time after completion of the flipped course, several factors must be noted that weaken the strength of any conclusions drawn from the survey results.

First, although the course material is similar regardless of the semester in which a course is offered, students surveyed may have had different Fluids and Thermodynamics instructors, even in the same semester. In addition, students may have taken the four courses over different periods of time and in a slightly different order (e.g., not take any of the listed courses during a semester; take two courses during the same semester rather than sequentially). Related to these concerns, a general issue in survey design that could not be addressed here is the poor reliability of memory recall, especially for recall on experiences that occurred a year or more prior to the survey. For example, many of the students surveyed took the material science course almost two years prior.

Perhaps the most important limitation, however, lies in the nature of the items attempting to determine the risk (i.e., frequency and severity) of cheating in each course. To improve response rate, the survey was structured to allow students to report cheating as a third party observer: for example, "Over the course of the semester, how many cheating incidents occurred in this course of which you were aware?" and "Why do you think the student(s) cheated in the incident(s)?" The third-party approach is a general guideline in survey design - particularly for survey items that include potentially incriminatory information - to allow respondents to include themselves in the reports without implicating themselves. However, the drawback is that the number of reported incidents is not necessarily the actual number of cheating incidents as several students may be reporting on the same cheating incident. Thus, when drawing inferences about the predisposition of students toward cheating in the different course formats, other anecdotal sources of information (e.g., instructor observation, student responses to open-ended questions on the survey) had to be taken into account.

Conclusions

The results of the survey indicate the students have strong opinions about the flipped classroom structure. Except for the question regarding student's feelings about fellow student cheating, all the questions yielded average values between 'strongly agree' and 'agree' for the flipped fluids course. Except for the specific cases given in the results, the opinions about the course were also statistically stronger than the other courses following a traditional format. The questions specifically addressing the student's perception of the course being effective at helping them learn and understand the material appears to also be confirmed by the increase in test scores as compared to the traditional lecture course. These results strongly support the efficacy of this pedagogy. While the results of the survey suggest a relationship between the flipped format and a reduction in cheating, further research is needed. Through the survey and the observations of delivering fluid mechanics in a flipped structure, the authors have formed an opinion that the format does in fact lead to less cheating and that the format contributes to improved student performance. However, the research presented here is only a pilot study; more stringent research and funding is needed to establish and assess the strength of any correlations between cheating, student performance and the flipped classroom instruction method.

References

[1] Lage, M., Platt, G. & Treglia M., (2000). Inverting the Classroom: A Gateway to Creating an Inclusive Learning Environment, *Journal of Economic Education*, 31(1), pp. 30-43.

[2] Talbert, R., (2012). Learning MATLAB in the Inverted Classroom, *Proceedings of the 2012 American Society for Engineering Education Annual Conference & Exposition*, AC 2012-3680.

[3] Waldorf, D.J. & Schlemer, L.T., (2011). The Inside-Out Classroom: A Win-Win-Win Strategy for Teaching with Technology, *Proceedings of the 2011 American Society for Engineering Education Annual Conference & Exposition*, AC 2011-1825.

[4] Morin, B., Kecskemety, K.M., Harper, K.A., & Clingan, P.A., (2013). The Inverted Classroom in a First-Year Engineering Course, *Proceedings of the 2013 American Society for Engineering Education Annual Conference & Exposition*, Paper 7230.

[5] Laman, J.A., Brannon, M.L. & Mena, I.B., (2012). Classroom Flip in a Senior-Level Engineering Course and Comparison to Previous Version, *Proceedings of the 2012 American Society for Engineering Education Annual Conference & Exposition*, AC 2012-4028.

[6] Talbert, R., (2014). The inverted classroom in introductory calculus: Best practices and potential benefits for the preparation of engineers, *Proceedings of the 2014 American Society for Engineering Education Annual Conference & Exposition*, Paper 10404.

[7] Cohen, P.A., Ebeling B.J., & Kulik, J.A., (1981). A meta-analysis of outcome studies of visual-based instruction, *Educational Technology Research and Development*, 29(1), pp. 26–36.

[8] McNeil, B.J., (1989). A Meta-analysis of interactive video instruction: A 10 year review of achievement effects. PhD thesis, University of Idaho.

[9] Zhang, D., Zhou, L., Briggs, R.O., & Nunamaker. J.F., (2006). Instructional video in e-learning: Assessing the impact of interactive video on learning effectiveness. *Information & Management*, 43(1), pp. 15–27.

[10] Bishop, J.L. & Verleger, M.A., (2013). The Flipped Classroom: A Survey of the Research, *Proceedings of the 2013 American Society for Engineering Education Annual Conference & Exposition*, Paper 6219.

[11] DeGrazia, J.L., Falconer, J.L., Nicodemusm G. & Medlin, W., (2012). Incorporating screencasts into chemical engineering courses, *Proceedings of the 2012 American Society for Engineering Education Annual Conference & Exposition*, AC 2012-5025.

[12] Meade, J. Cheating: Is academic dishonesty par for the course?, *ASEE Prism*, 1992, 1, 30-2.

[13] Passow, H.J., Mayhew, M.J., Finelli, C.J., Harding, T.S. & Carpenter, D.C. (2006). Factors influencing engineering students' decisions to cheat by the type of assessment. *Research in Higher Education*, 47:6, pp. 643-684.

[14] Widmann, J., & Shollenberger, K. (2006). Student use of textbook solution manuals: Student and faculty perspectives in a large mechanical engineering department, *Proceedings of the 2006 American Society for Engineering Education Annual Conference & Exposition*, 2006-756.

[15] Minichiello, A.L., McNeill, L.S. & Hailey, C.E. (2012). Comparing engineering student use of solution manuals and student/faculty perceptions of academic dishonesty, *Proceedings of the 2012 American Society for Engineering Education Annual Conference & Exposition*, AC 2012-3181.

[16] Carpenter, D.D., Harding, T.S., Finelli, C.J., Montgomery, S.M. & Passow, H.J. (2006). Engineering student's perceptions of and attitudes towards cheating, *Journal of Engineering Education*, 95(3), pp. 181-194.

[17] Novotney, A., Beat the cheat, *Monitor on Psychology*, June 2011, p. 54. American Psychological Association, Retrieved from http://www.apa.org/monitor/2011/06/cheat.aspx

[18] Anderman, E.M. & Murdock, T.B. (2007). Psychology of Academic Cheating, Elsevier.

[19] Rettinger, D.A. & Jordan, A.E. (2005). The Relations Among Religion, Motivation, and College Cheating: A Natural Experiment, Ethics and Behavior, 15(2), pp. 107-129.

[20] Martin, M.W., (2013). Implementing Active Learning Principles in an Engineering Technology Fluid Mechanics Course, *Proceedings of the 2013 American Society for Engineering Education Annual Conference & Exposition*, Paper 6134.

[21] Lang, H.R. & McBeath A., (1992). Fundamental Principles and Practices of Teaching: A Practical Theory-Based Approach to Reflective Planning and Instruction, Faculty of Education, University of Regina.

Appendix A: Student Survey

TOPIC: **Course Name**

Please rate the following questions based on the scale given below.

1	Strongly Disagree
2	Disagree
3	Neutral
4	Agree
5	Strongly Agree

1. The course was effective in helping me learn the material presented.	**1**	**2**	**3**	**4**	**5**
2. The course was effective in helping me to understand	1	2	3	4	5

the material.					
3. The course format/delivery method encouraged cheating.	1	2	3	4	5
4. I enjoyed the course.	1	2	3	4	5
5. I was interested in the material presented.	1	2	3	4	5
6. It would bother me if other student(s) cheated during this course.	1	2	3	4	5

When did you take this course? (term / year) ____

Over the course of the semester, how many cheating incidents occurred in this course of which you were aware?

- None (Skip to the next course)
- 1
- 2-3
- 4 or more

Over the course of the semester how many students (total) do you think were involved in the incident(s)?

What types of cheating were involved in the incident(s)? (mark all that apply)

○ Solutions copied from web
○ Solutions copied from solution manual/textbook
○ Solutions copied from a fellow student
○ Solutions copied from prior semester material
○ Smartphone use during an exam
○ Other (please describe:____)

Why do you think the student(s) cheated in the incident(s)?

Did the cheating incident(s) in the class bother you? Why or Why Not?