122nd ASEE Annual Conference & Exposition
June 14 - 17, 2015
Seattle, WA

Paper ID #11618

Use of mobile learning strategies and devices for e-portfolio content creation in an engineering Thermodynamics and Fluid Mechanics classes: Student perceptions

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Background

Mobile devices like tablets and smartphones, if used judiciously, can enable ubiquitous learning[1] as well as anytime, anywhere communication. Mobile phones have been found to be more effective in teaching students vocabulary than traditional learning tools like flashcards[2]. Sometimes, students prefer to receive their lesson content via a mobile phone rather than a personal computer[3]. It can help students develop higher order thinking skills like reflection[4] as well as support the learning of information management, communication, and time management skills[5].

Most students have a positive attitude towards the use of mobile devices in learning[6]. Students who perceive mobile device-based learning to be useful in the long-term, are more likely to view the use of mobile devices as useful in the short-term[7]. While many students readily adopt the use of mobile devices to enhance their learning, others may need help in recognizing their utility[8]. Moreover, all students may not learn equally in a mobile learning environment. For example, students with a low working memory capacity were seen to not perform well in a mobile learning environment[9]. In this context, it might be of value to study engineering student perceptions on the use of mobile teaching and learning strategies as well as devices, to create class related digital content.

Purpose of study

The goal of this study was to determine whether the use of mobile learning strategies and devices enable students to perceive themselves as efficient creators of electronic content for inclusion in their e-portfolios. The purpose of this study was to determine student perceptions on the efficacy of using mobile learning strategies and devices to create electronic content.

Using e-portfolios for teaching and learning may benefit students in several ways. It may increase student awareness of learning progress and help build on their learning experiences through reflection[10]. Often, the use of e-portfolios correlate with higher levels of student success, as indicated by parameters like higher course pass rates, higher Grade Point Averages, credit accumulation, retention, and graduation rates[11]. Skills can be taught which are consistent across programs, as well as customized to fit individual courses[12]. E-portfolios can support assessment by identifying goals and providing a repository for organizing, storing, and sharing records. It is instructionally valuable in that students can connect their own work with the broader program expectations, thus self-evaluating their status. Students can engage in reflection, which may develop their critical thinking skills.

This study is a follow-up to a previous study made by the researchers[13] (see Bose & Pakala, 2014), where students were grouped into teams and created digital content for their group e-

portfolios. Each group in that study was loaned a single mobile device (iPad), which was shared by group members to create course related content.

Students enrolled in undergraduate 300-level engineering Thermodynamics and Fluid Mechanics classes, created videos and produced content demonstrating course material summaries and problem solving techniques. A post course completion anonymous survey and focus group meetings were conducted at the end of the semester, to document student perceptions on the efficacy of using mobile learning strategies and devices to create digital content for inclusion in their e-portfolios. Based on the observances made in this study, recommendations were made on how to use mobile learning strategies and devices for effective teaching and learning.

Research hypothesis

The hypothesis of this study was that students would find the use of mobile learning strategies and devices to be efficient means of creating digital content for inclusion in their engineering e-portfolios.

The following research questions guided this study:

1. What are the perceptions of the effect of using mobile learning strategies and devices on participants' creation of individual e-portfolios, as reported through a qualitative analysis of a post-course completion survey?
2. What are the perceptions of the effect of using mobile learning strategies and devices on participants' creation of individual e-portfolios, as reported through a qualitative analysis of post-course completion focus group meetings?

Methods of data collection

The phenomenon under study was the effect of using mobile learning strategies and devices on student learning and content creation for e-portfolios, measured through a self-reported survey and focus group meetings (See Appendix A for instruments).

Students enrolled in a 300-level engineering Thermodynamics and a Fluid Mechanics course, created multimedia videos and produced content demonstrating course content summaries, problem solving techniques.

At the end of the semester, students participated in an anonymous online survey distributed via an online survey management tool (Qualtrics.com). They also participated in focus group meetings, where the meeting proceedings were audio recorded. Creation of electronic content for their e-portfolio was a necessary part of completing the requirements of the course, and was therefore a grade bearing activity. However, participation in the survey and the focus group meeting were voluntary and did not affect student grades for the course. Students did not receive any extra credit for participating in the survey or focus group meetings.

Procedures

During the course of the summer semester, students enrolled in both the courses worked individually to produce digital content demonstrating course content summaries, problem-solving techniques. Students used the mobile device to create screen-captured videos (using the *Explain Everything* application) on engineering problem solutions. (See Appendix B for links to student e-portfolios, which contain the videos). These products were uploaded into their individual course e-portfolio. Instructions for/expectations for completion of the digital videos were provided (See Appendix B). The mobile device (iPad) was also used to complete in-class quizzes using an application.

At the end of the semester, students were invited to participate in a voluntary and anonymous online survey (20 item Likert scale instrument) regarding their perceptions of the efficacy of using mobile learning strategies and devices to create electronic content for inclusion in their e-portfolios. The survey was delivered via an online survey management platform (Qualtrics.com) and took about 10 minutes to complete. The survey questions were based on elements of rubrics, used to grade the digital video content created by the students in the Fluid Mechanics and Thermodynamics classes. Obtaining these grades were a regular part of completing the requirements of these classes and was not included in the data collected for this study.

At the end of the semester, students were also invited to participate in voluntary focus group meetings. Twenty one students out of a class of fifty one, volunteered to participate. All the meetings were held on the same day and were moderated by one of the researchers (who was not the instructor of the course). They were guided by five pre-determined questions designed to elicit student perceptions on the use of mobile learning strategies and device.

Sample

Participants who volunteered to take part in this study consisted of registered students in an undergraduate 300-level engineering Thermodynamics course and a Fluid Mechanics course, who took these courses as part of completing the requirements for obtaining their undergraduate degree. The combined total number of students in both classes was 51 (33 from Fluid Mechanics and 18 from Thermodynamics). Forty five students out of a total of fifty one, responded to the anonymous survey, while twenty one participated in the Focus Group meetings.

Results

Two instruments were used to collect data for this study: 1) A 20 item, five point Likert scale survey which was electronically delivered using an electronic survey management and delivery system (Qualtrics.com); 2) a five item Focus Group Meeting discussion guideline. This guideline was used to guide discussions during the face-to-face Focus Group meetings.

Survey results

Forty five students out of a class of fifty one responded to the survey. The survey had a total of 20 items, out of which 11 items were aimed towards determining whether the use of mobile

devices helped students create electronic content materials included in the e-portfolio. Nine items were targeted towards determining whether the use of the mobile device to create content supported good teaching and learning strategies. The following table lists the percentage of students who either "Agree" or "Strongly Agree" that the mobile device supported them in the completion of various aspects of the e-portfolio content creation process:

Aspects of content creation	**Percentage of students who either "Agree" or "Strongly Agree"**
1. Demonstrate appropriate solution format.	91%
2. Create a clear and appropriately labeled sketch.	73%
3. List pertinent assumptions.	76%
4. State, apply, and document all governing equations and assumptions.	76%
5. Document use of Property Tables throughout the problem solution process.	51%
6. Document use of appropriate mathematical notations.	71%
7. Document use of correct units in each step of the solution process and in the answer.	64%
8. Demonstrate appropriate mathematical calculations.	69%
9. Demonstrate appropriate graphs, label axis and curves.	58%
10. Note significant results.	73%
11. Complete discussion of the solution.	73%

Table 1. Student perceptions of aspects of the e-portfolio content creation process using a mobile device (iPad).

As seen in the above table (Table 1), more than 90% of the participants found it convenient to use a mobile device (iPad) to demonstrate problem solutions in the appropriate format. Content created for this class was primarily videos demonstrating engineering problem solutions, created using the mobile application *Explain Everything*. The video content included screen captures of electronic whiteboards with voiceovers explaining the solutions.

More than 70% of the participants found it easy to use the application to label, sketch, list assumptions, apply and document governing equations, document mathematical notations, note results, and complete the discussion of the solutions. Therefore, the nature of the tasks the users could easily accomplish using a mobile device, were related to using a mobile application based electronic whiteboard to visibly document and verbally explain their solution of engineering

problems. However, there were some aspects of documentation where the percentage of reported success/comfort of use dropped to lower figures.

Only 51% of the participants were able to comfortably use the mobile device and the application to document the use of Property Tables during the problem solution process. Use of Property Tables is an inherent part of a thermodynamics problem solution process. Many instructors require students to document this use, as evidence of mastering knowledge of the steps towards the solution to the problem. A similar lower percentage (64%) of students found it comfortable to use the mobile device and application to document use of correct units during the solution process. Participants were expected to use a stylus to write the solution process on the digital whiteboard made available through the *Explain Everything* application. This study did not ask follow up questions to the participants on why they found documentation of units particularly difficult.

Creation of graphs and the labeling of axis and curves were also areas of difficulty, since only 58% of the participants expressed that they were comfortable in doing it. It appears that creating/importing a graph or labeling its component parts from within the *Explain Everything* application, was not an easy task for many students.

While more than 90% of the participants reported that they were comfortable using the iPad and the application to demonstrate content in the digital video format, only 69% reported that it was convenient to demonstrate the appropriate mathematical calculations. Students were required to demonstrate their problem solution in writing, using the whiteboard feature of *Explain Everything*. During the Focus Group interviews, some students mentioned that the quality of the stylus provided was inferior and this often made writing on the touchscreen difficult. Hence, this may be a reason why demonstration of the problem solution via writing on a mobile device touchscreen may have been difficult.

The following table lists the percentage of students who either "Agree" or "Strongly Agree" on various aspects of whether the use of the mobile device to create content was a good teaching and learning strategy:

Aspect of mobile device use as a good teaching and learning strategy	**Percentage of students who either "Agree" or "Strongly Agree"**
1. Be more organized for class.	82%
2. Access multiple information resources while learning about a particular topic.	91%
3. Become a more efficient note taker.	60%
4. Turn in homework, assignments, and tests more efficiently.	80%
5. Receive instructor feedback more quickly and efficiently.	89%
6. Create content that demonstrates learning more efficiently.	69%
7. Master content.	69%

8. Communicate with instructor more easily.	58%
9. Prepare better for examinations.	84%

Table 2. Student perceptions of aspects of good teaching and learning strategy, enabled by use of a mobile device (iPad).

With regard to ways in which the implementation of good teaching and learning strategies were supported by the use of mobile devices, at least 80% of the participants reported that use of the iPad enabled them to be better managers of information (more organized for class; access multiple sources of information). Students were able to receive feedback more frequently from their instructor (turn in homework, assignments, tests; receive instructor feedback). However, even though students had access to a mobile device, it was not necessarily used to communicate with the instructor, with only 58% of the participants reporting that it made communication easier. Preparation for examinations for 84% of the participants was facilitated through use of mobile devices.

Only 69% of the participants felt that content creation and mastery of concepts was facilitated through use of mobile devices. This might be in keeping with results from another segment of the survey, where some participants reported that use of the mobile device did not facilitate them in the use of Property Tables.

Focus Group Meeting

Data was collected via Focus Group meetings and used to triangulate the findings from the survey. Twenty one students out of a class of fifty one, voluntarily participated in the Focus Group meetings. One of the researchers (who was not the instructor of the course) met with the participants face-to-face in an on-campus location and audio-recorded their verbal responses. The following paragraphs summarize participant responses under themes, which best reflect the guiding questions used during the Focus Group meetings.

Engagement with course materials

The use of mobile devices to create content for the e-portfolio reportedly increased student engagement with course materials. The act of creating videos, verbalizing and demonstrating each step of a problem solution helped students, review course materials, to think deeply and to retain information better. Using the mobile device saved a lot of time in terms of students being able to take and organize their notes more efficiently. However, uploading the video content into the e-portfolio was often too time consuming and cumbersome.

Interaction with the instructor

The use of the mobile device to create content for the e-portfolio did not necessarily lead to interaction with the instructor other than receiving feedback regarding the content. Students did not receive any feedback via the e-portfolio system and often found it easier to meet the instructor face-to-face to ask questions or interact. However, the use of applications like Dropbox improved communication since students were able to receive instant feedback on

assignments from the instructor. Some students found it technically challenging to create content using the mobile device and this made them approach the instructor for help.

Advantages and disadvantages of using mobile devices for content creation

Most students found that there were more advantages to disadvantages in using mobile devices for creating course content. The advantages included being able to create evidence of learning, which could be repeatedly viewed, stored, and shared with other people. The act of creating the videos improved understanding since it required going through and reflecting on each step of the problem solution. A single device which provided portable, easy access to content, on and offline, was an advantage. The iPad also enabled students to easily write, store, and organize their notes in a single place. Where there was access to the internet, students were able to search for additional information on the go, wherever and whenever they needed. It was easy to create and directly upload or store content using the same device. Some students were able to learn how to use the iPad and e-portfolios for the first time during this class, which they hope to be able to use in their future careers.

The disadvantages included the fact that it was time consuming to use some of the applications to create videos. The poor quality stylus provided to the student was a deterrent since students were often unable to read their previously saved notes. Students who had never used an iPad before had a steep learning curve. Easy access to the internet through the iPad was often a source of distraction.

Use of mobile devices in future learning

Students mentioned that they would use the iPad to take notes as well as use other convenient applications. It would also be used to do homework and search for information as well as to access e-books. One student mentioned that after using the iPad for this class, she would be using her personal iPad for her future classes more than she had done in the past.

Suggested changes for use of mobile devices in future

While most students reported liking the way mobile devices were used to create content for the e-portfolio, some students mentioned that since creating content was quite time consuming, the e-portfolio should be worth more points. Students mentioned that the course instructor was an enthusiastic user of technology in the classroom, however, students would benefit if more time was dedicated to teach students how to use the device and applications. In general, students liked how the class was designed such that it was not compulsory for them to use mobile devices, though the use of mobile devices enhanced their content creation experience. One student thought that storing the video content in an e-portfolio was a waste of time and effort, when the created content could easily have been stored in a cloud storage applications like Dropbox.

Limitations

This study had several limitations that are worth considering. Participants responded to a Likert scale based electronic survey. No open-ended comments options were provided for respondents

to expand on/provide further information regarding their choices. There were no follow-up questions asked during the Focus Group meetings on the low scoring survey items. Hence, limited qualitative data was collected on reasons behind participants' choices.

Data for this research was gathered via a post-instruction electronic survey and focus group meetings. No data on the pre-instruction experience was gathered to compare with the post-instruction experience. Hence, the researchers have no information on whether taking the course in itself had any impact on participants' perceptions, or whether there was a change in perceptions between before and after taking the class.

No data was gathered on the base technology experience levels of the participants. Some participants may have been more or less technology savvy than others. This may have an impact on their ability to use the iPad and the application to create content for this class.

The sample for this research consisted of participants from both the Fluid Mechanics and the Thermodynamics classes. Separate data from each class was not reported. The electronic survey was anonymous and hence participants cannot be traced back to the class roster. During the focus group meeting, participants were not asked to identify their class type. Hence no information is available on whether participants from one class felt differently from that of another.

Discussion

Results from the survey indicated that at least 51% of the participants either Agree or Strongly Agree that the mobile device supported them in the completion of various aspects of the e-portfolio content creation process. Moreover, at least 60% of the participants thought the same, when it came to deciding whether the use of a mobile device supported an efficient teaching and learning strategy. In general, students perceived that the use of an iPad to create content increased their engagement with course materials. They thought more deeply about the content and retained longer.

Though most students found that the use of the iPad increased their interaction with the course instructor, some participants found the use of the device for content creation, to be technologically challenging. This had a positive impact on student-instructor communication, in that it encouraged some students to contact the instructor for help with using the device.

While the use of the iPad was found to be advantageous for most students, some reported certain disadvantages. It was often time consuming to use some of the applications to create videos, which time could have been better utilized studying. Students who had never used an iPad before, experienced a steep learning curve. Also, the easy access to the internet through the device was often a source of distraction from focusing on course materials. Most students mentioned that they would continue to use mobile devices in future for educational, entertainment, as well as for professional purposes. One of the suggestions to improve this class included more time dedicated to teach students how to use the device and the applications. This highlights the importance of the instructor modeling use as well as the provision of training resources for students.

Recommendations for teaching and learning

Based on the survey results and the Focus Group meeting data, the authors have several recommendations that can be made which may have an impact on future teaching and learning practices using mobile devices and mobile teaching and learning strategies. While there may be numerous ways in which mobile teaching, learning strategies as well as devices, which may be used to enhance instruction and learning, the following recommendations pertain to some of those that have emerged, at the end of this particular study:

- The instructor should be a role model for use of mobile devices for teaching and learning to his students. In this study, student participants reported that their course instructor was an enthusiastic user of mobile devices and implemented its use for teaching and learning in the classroom. Students were required to use a mobile device to create video content for the class, thus forcing technology shy students to try out new ways of learning and demonstrating that learning.
- The instant connectivity offered by mobile devices may often lead to students being distracted away from productive academic pursuits. Participants in this study mentioned that the availability of the iPad often made them use it to access social media sites during class as well as when they should have been doing their homework. Hence, instructors should attempt to make innovative use of the connectivity afforded by the devices to design instruction that fulfills learning goals and follows good teaching and learning practices. For example, students may be asked to engage in a community of learning using social media sites (like Facebook and Twitter), where they can learn actively through sharing, connection, and peer collaboration.
- In order to make maximum use of a mobile device for teaching and learning, students should receive training on the use of the device and applications. Some participants in this study mentioned that they experienced a steep learning curve during their use of the iPad and the suggested applications to create content for the class. Device and application training resources should be made readily available for students in order to facilitate easy adoption and continued use.
- The focus of this study was on the use of mobile devices for content creation. However, students also used cloud storage applications like Dropbox for improved communication and to receive feedback on assignments from the instructor. Mobile devices can be used effectively as student response systems to conduct classroom polls and receive feedback on student progress or understanding[14].

Further Research

The goal of this study was to determine whether benefits derived from the use of mobile learning strategies and devices, enable students to become efficient creators of electronic content for inclusion in their e-portfolios. The researchers intend to conduct a future study to determine whether and how effectively, engineering students can use e-portfolios to reflect on the digital content they make using mobile devices. Students will upload videos documenting their solution to engineering problems in their individual e-portfolios. Their peers will review and comment on the quality and efficacy of these solutions. Students will later reflect on their solution, based on the comments received from peers and thus have a chance to improve the solution approach. The

peer review will be conducted based on an instructor provided rubric (based on course learning outcomes).

Conclusion

Findings from this study indicated that most participants perceived the use of mobile teaching and learning strategies and devices to increase their engagement with course materials as well as lead to deeper learning and retention of materials learned. It led to better interaction with the instructor through use of cloud based sharing applications. Several advantages and disadvantages of using mobile devices were noted as were suggestions for future use. Most students felt that they would continue to use mobile devices for their future learning as professional engineers. Several limitations to this study were also noted. Plans for further research include a study on student use of mobile devices to create content that may be used for peer review and reflection, thus enhancing engineering problem-solving and critical thinking skills.

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Appendix A

Survey Questions

On a scale of 1 to 5 (where 1 denotes "Strongly Disagree" and 5 denotes "Strongly Agree") indicate your level of agreement to the following statements. You may select the "NA" (Not Applicable) option if required:

1. While presenting the solution to a course related problem, the use of mobile devices helped you to demonstrate the appropriate solution format.

Strongly Disagree 1	Disagree 2	Undecided 3	Agree 4	Strongly Agree 5	NA

2. While presenting the solution to a course related problem, the use of mobile devices helped you to create a clear sketch and label it appropriately.

Strongly Disagree 1	Disagree 2	Undecided 3	Agree 4	Strongly Agree 5	NA

3. While presenting the solution to a course related problem, the use of mobile devices helped you to list the pertinent assumptions.

Strongly Disagree 1	Disagree 2	Undecided 3	Agree 4	Strongly Agree 5	NA

4. While presenting the solution to a course related problem, the use of mobile devices helped you to state, apply, and document all governing equations and assumptions.

Strongly Disagree 1	Disagree 2	Undecided 3	Agree 4	Strongly Agree 5	NA

5. While presenting the solution to a course related problem, the use of mobile devices helped you to document your use of the property tables throughout the solution.

Strongly Disagree 1	Disagree 2	Undecided 3	Agree 4	Strongly Agree 5	NA

6. While presenting the solution to a course related problem, the use of mobile devices helped you to document the use of appropriate mathematic notations.

Strongly Disagree 1	Disagree 2	Undecided 3	Agree 4	Strongly Agree 5	NA

7. While presenting the solution to a course related problem, the use of mobile devices helped you to document the use of correct units in each step of the solution process and in the answer.

Strongly Disagree 1	Disagree 2	Undecided 3	Agree 4	Strongly Agree 5	NA

8. While presenting the solution to a course related problem, the use of mobile devices helped you to demonstrate the appropriate mathematical calculations.

Strongly Disagree 1	Disagree 2	Undecided 3	Agree 4	Strongly Agree 5	NA

9. While presenting the solution to a course related problem, the use of mobile devices helped you to demonstrate the appropriate graphs, label the axis and curves.

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

10. While presenting the solution to a course related problem, the use of mobile devices helped you to note significant results.

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

11. While presenting the solution to a course related problem, the use of mobile devices helped you to complete the discussion of the solution's significance.

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

12. The use of mobile devices helped you to be more organized for class.

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

13. The use of mobile devices has helped you to access multiple information resources while learning about a particular topic.

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

14. The use of mobile devices has helped you to become a more efficient note taker utilizing its many annotation capabilities.

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

15. The use of mobile devices has helped you to turn in homework, assignments, and tests more efficiently.

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

16. The use of mobile devices has helped you to receive feedback (on assignments, homework, tests) from your instructor more quickly and efficiently.

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

17. The use of mobile devices has helped you to create content demonstrating your learning more efficiently.

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

18. By creating videos demonstrating your learning, you were able to master the content better than you would have been able to otherwise.

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

19. The use of mobile devices has helped you to communicate with your instructor more easily through virtual office hours (Happy Hours).

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

20. The use of mobile devices helped you to prepare better for your examinations.

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

Focus Group Questions

1. How did the use of mobile devices for e-portfolio content creation, affect the nature of your engagement with the course materials?

2. How did the use of mobile devices for e-portfolio content creation affect the level of interaction you had with your course instructor?

3. What were the advantages and disadvantages of using mobile devices for content creation?

4. How would you use mobile devices for your learning in future?

5. If you were the instructor for this class, what changes would you suggest in the ways in which mobile devices were used for teaching and learning in this class?

Appendix B

The following are links to e-portfolios, which contain participant created digital content. Permission has been obtained from the owners for their use in this study:

ME 302: Thermodynamics I - Example 1 :https://boisestate.digication.com/jillian_helms
ME 302: Thermodynamics I - Example 2 :https://boisestate.digication.com/lauren5
ME 330: Fluid Mechanics - Example 1 :https://boisestate.digication.com/andrew_aitchison
ME 330: Fluid Mechanics - Example 2 :https://boisestate.digication.com/john_amos

The following rubrics (used to grade the video content created by students in the Thermodynamics and Fluid Mechanics classes) were used as the basis for creating the questions in the survey used for this study:

ME 302: Thermodynamics I Grading Rubric Summer 2014

Objectives	Criteria	Unacceptable Performance	Partially Proficient Performance	Proficient Performance	Engineering Performance	Problem	
Solution Presentation	Solution Format	***0 points*** Solution format is not followed.	***2 points*** Solution format is partially followed.	***4 points*** Solution format is mostly followed.	***6 points*** Solution format followed.		
	Sketch	***0 points*** No sketch/FBD are indicated.	***2 point*** A sketch/FBD is presented but is not clear. Minimal labeling.	***4 points*** A clear sketch/FBD is presented. Some clear labeling.	***6 points*** A clear sketch/FBD is presented and clearly labeled.		20 points total
	Assumptions	***0 points*** No assumptions are indicated.	***3 points*** Some assumptions are listed but not always pertinent.	***6 points*** Most assumptions are listed but not always pertinent.	***8 points*** Pertinent assumptions are listed.		
Problem Solving Approach	Governing Equations/ Assumptions	***0 points*** No governing equations or assumptions used in the analysis	***8 points*** Some governing equations and assumptions stated in analysis and applied.	***16 points*** Most governing equations and assumptions stated and properly applied.	***24 points*** All Governing equations and assumptions stated, applied and documented.		
	Use of Tables and Properties	***0 points*** Significant errors in the use of tables.	***3 points*** Some errors in the use of tables.	***6 points*** Minor errors in determining properties from tables. (misreading line)	***8 points*** Accurate use of tables throughout solution.		44 points total
	Mathematical Skills	***0 points*** No demonstration of mathematical skills.	***4 points*** Several errors in the mathematical solution steps.	***8 points*** Mathematical solution steps mostly correct through problem.	***12 points*** Proper use of mathematics throughout problem.		
Results Presentation	Units	***0 points*** No units used in calculations or answer.	***3 points*** Units sometimes used in solution process.	***6 points*** Units mostly used in solution process.	***8 points*** Correct units used through each step in solution process and answer.		
	Mathematical Accuracy	***0 points*** Many mathematical calculation errors throughout solution.	***3 points*** Several mathematical calculation errors in solution.	***6 points*** Minimal mathematical calculation errors in solution.	***8 points*** No mathematical calculation errors in solution.		36 points total
	Presentation of Solution	***0 points*** No graph presented/No Discussion	***4 points*** Graph presented incorrectly or without labels and clear axes./Minimal discussion of solution	***6 points*** Graph accurately presented with most labeling./Some discussion of solution significance	***10 points*** Graph accurately presented with all labeling of axes, curves. Significant results noted./Complete discussion of solution significance		
	Solution Accuracy	***0 points*** Incorrect Answer		***10 points*** Correct Answer			
						SCORE:	
						POINTS:	
						TOTAL:	

Some additional guidelines for the videos	
1	Original problem read out
2	Work written neatly
3	All steps written clearly
4	Problem well thought out
5	Main point/concept is clearly identified
6	Voice clarity/graphics
7	Inclusion of any helpful hints to pass along to your peers / words of wisdom

ME 330: Fluid Mechanics Grading Rubric Summer 2014

Objectives	Criteria	Unacceptable Performance	Partially Proficient Performance	Proficient Performance	Engineering Performance	Problem	
Solution Presentation	Solution Format	*0 points* Solution format is not followed.	*2 points* Solution format is partially followed.	*4 points* Solution format is mostly followed.	*6 points* Solution format followed.		
	Sketch	*0 points* No sketch/FBD are indicated.	*2 point* A sketch/FBD is presented but is not clear. Minimal labeling.	*4 points* A clear sketch/FBD is presented. Some clear labeling.	*6 points* A clear sketch/FBD is presented and clearly labeled.		20 points total
	Assumptions	*0 points* No assumptions are indicated.	*3 points* Some assumptions are listed but not always pertinent.	*6 points* Most assumptions are listed but not always pertinent.	*8 points* Pertinent assumptions are listed.		
Problem Solving Approach	Governing Equations/ Assumptions	*0 points* No governing equations or assumptions used in the analysis	*8 points* Some governing equations and assumptions stated in analysis and applied.	*16 points* Most governing equations and assumptions stated and properly applied.	*24 points* All Governing equations and assumptions stated, applied and documented.		
	Use of Tables and Properties	*0 points* Significant errors in the use of tables.	*3 points* Some errors in the use of tables.	*6 points* Minor errors in determining properties from tables. (misreading line)	*8 points* Accurate use of tables throughout solution.		44 points total
	Mathematical Skills	*0 points* No demonstration of mathematical skills.	*4 points* Several errors in the mathematical solution steps.	*8 points* Mathematical solution steps mostly correct through problem.	*12 points* Proper use of mathematics throughout problem.		
Results Presentation	Units	*0 points* No units used in calculations or answer.	*3 points* Units sometimes used in solution process.	*6 points* Units mostly used in solution process.	*8 points* Correct units used through each step in solution process and answer.		
	Mathematical Accuracy	*0 points* Many mathematical calculation errors throughout solution.	*3 points* Several mathematical calculation errors in solution.	*6 points* Minimal mathematical calculation errors in solution.	*8 points* No mathematical calculation errors in solution.		36 points total
	Presentation of Solution	*0 points* No graph presented/No Discussion	*4 points* Graph presented incorrectly or without labels and clear axes./Minimal discussion of solution	*6 points* Graph accurately presented with most labeling./Some discussion of solution significance	*10 points* Graph accurately presented with all labeling of axes, curves. Significant results noted./Complete discussion of solution significance		
	Solution Accuracy	*0 points* Incorrect Answer		*10 points* Correct Answer			
						SCORE:	
						POINTS:	
						TOTAL:	

Some additional guidelines for the videos	
1	Original problem read out
2	Work written neatly
3	All steps written clearly
4	Problem well thought out
5	Main point/concept is clearly identified
6	Voice clarity/graphics
7	Inclusion of any helpful hints to pass along to your peers / words of wisdom

The following descriptions/completion expectations were provided to students in the Fluid Mechanics and Thermodynamics classes for completing their digital content:

Fluid Mechanics e-Portfolio (FLUME)

"We are currently preparing students for jobs that don't yet exist….using technologies that haven't yet been invented…in order to solve problems we don't even know are problems yet."
-Richard Riley, Former Secretary of Education

This project is aimed at achieving mastery of the subject matter through development of key skills such as:

- Oral and written communication

- Critical thinking and problem solving
- Professionalism and work ethic
- Applying technology
- Project management

The table below lists three projects and their due dates.

	Project 1 CHs. 1, 2, 3	**Project 2 CHs. 4, 5, 6**	**Project 3 Chs. 7, 8**
Due Date	**Tue, Jun 24th, 2014**	**Tue, Jul 15th, 2014**	**Tue, Jul 29th, 2014**
Videos	Chapters' summary	Chapters' summary	Summary of CH. 7
	Problem 1*	Problem 1*	Summary of CH. 8
	Problem 2*	Problem 2*	Problem 1*
	Problem 3*	Problem 3*	Problem 2*

Note: Individual projects are due as indicated by 11:59 PM.
*** These problems are posted on blackboard**

Chapters' summary: You will create a video summarizing the chapters emphasized on the exam. This video should provide a summary of the major concepts from each chapter. Additionally, identify the important equations. When can they be used? When should they not be used?

Problem Solution Videos: These videos should provide a concise exposition of the solution to the assigned problem. Identify the type of problem, the problem-solving strategy to be used, and the major equations necessary to solve the problem. Do not waste time drawing pictures or performing calculations on the video. You will need to solve the problem before creating the video.

Finally for each project you will upload to "Digication" (e-Portfolio software).

Thermodynamics e-Portfolio (TEMPO)

"We are currently preparing students for jobs that don't yet exist….using technologies that haven't yet been invented…in order to solve problems we don't even know are problems yet."
-Richard Riley, Former Secretary of Education

This project is aimed at achieving mastery of the subject matter through development of key skills such as:

- Oral and written communication
- Critical thinking and problem solving
- Professionalism and work ethic
- Applying technology
- Project management

The table below lists three projects and their due dates.

	Project 1 CHs. 1, 2, 3	Project 2 CHs. 4, 5, 6	Project 3 Chs. 7, 9
Due Date	**Tue, Jun 24th, 2014**	**Tue, Jul 15th, 2014**	**Tue, Jul 29th, 2014**
Videos	Chapters' summary	Chapters' summary	Summary of CH. 7
	Problem 1*	Problem 1*	Summary of CH. 9
	Problem 2*	Problem 2*	Problem 1*
	Problem 3*	Problem 3*	Problem 2*

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