AC 2008-2148: DEVELOPMENT, IMPLEMENTATION AND ASSESSMENT OF A PROGRESSIVE READING LOG SYSTEM

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Development, Implementation and Assessment of a Progressive Reading Log System

Abstract

Students in upper-level Engineering classes such as Fluid Mechanics often find themselves faced with over 60 pages of reading a week in addition to assigned problems and exam preparation. Since the reading of the textbook is often infrequently assessed, this aspect of course learning is often postponed or omitted. In addition, with this amount of reading, many students quickly find themselves so far behind in the reading that they can no longer catch up.

A reading log system where content responsibility is progressively shifted from the instructor's questions to student identification and reflection has been developed and implemented in junior-level Fluid Mechanics and Thermodynamics courses to address several of the issues associated with student use of the textbook. The goal of the reading log is to improve student use of resource material and to provide opportunities for students to develop skills in reading scientific material. Reflective questioning, guided identification of key concepts, probing questions and cyclic problems are some of the tools that are used to stimulate student use of the textbook. In addition, the progressive content of the reading logs is designed to transition the student from rote learning to self-reflection and synthesis of understanding. To evaluate the effectiveness of the resource, student surveys and responses to reading log questions have been used to guide its development.

Background

Reading logs are an educational tool used by students to "record what they have read, respond personally to and analyse texts."[1] Moon[2] lists dozens of different ways in which the reading log (learning journal) can be implemented depending on the objective and scope of its application. The central point for each implementation of the learning journal is that the journal is a device for students to reflect on their contact with content. This is of special benefit since reflection "is seen as a skill that is of benefit to both learners and professionals since it usually results in efficient learning, changed thinking and revision of practice."[3] Depending on the structure of the assignment, the reading log can be used exclusively for the student to summarize and revise the content covered or it can incorporate guided questions to explicitly promote thinking processes or connections to other subject matter. As such, this process of reflection also encourages metacognition[2]

While reading logs are considered accepted practice in K-12 education or in Humanities programs, their use in the Engineering or Physical Sciences is limited. Grumbacher[4] used the journal process to examine the relationship between writing processes and problem solving and found that students who were better problem solvers are better able to use their learning logs as vehicles to synthesize new knowledge. Other authors, such as Selfe and Arbabi[5] and Gibbs[6], have used these journals as vehicles for engineering students to develop their writing skills while at the same time clarifying their thinking processes and developing problem solving strategies. They also used the journals to encourage the students to identify areas where they needed more help with the material. More recently, Feest and Iwugo[3] reported on the use of a

one-minute paper form of the reading log to enhance student learning in Water and Environmental Management courses.

In addition to promoting reflective thinking, reading logs are also "a useful way for teachers' to monitor student reading." [1] While this may seem pedantic and overly intrusive in post-secondary education, it is well recognized that, for the most part, undergraduate students are still in the process of becoming lifelong and self-motivated learners. A version of a reading log, published by the Pacific Crest Teacher Institute, and a modified version that transforms from a guided worksheet to an independent, free-form log were implemented in junior-level classes over the course of three quarters (terms) at Kettering University.

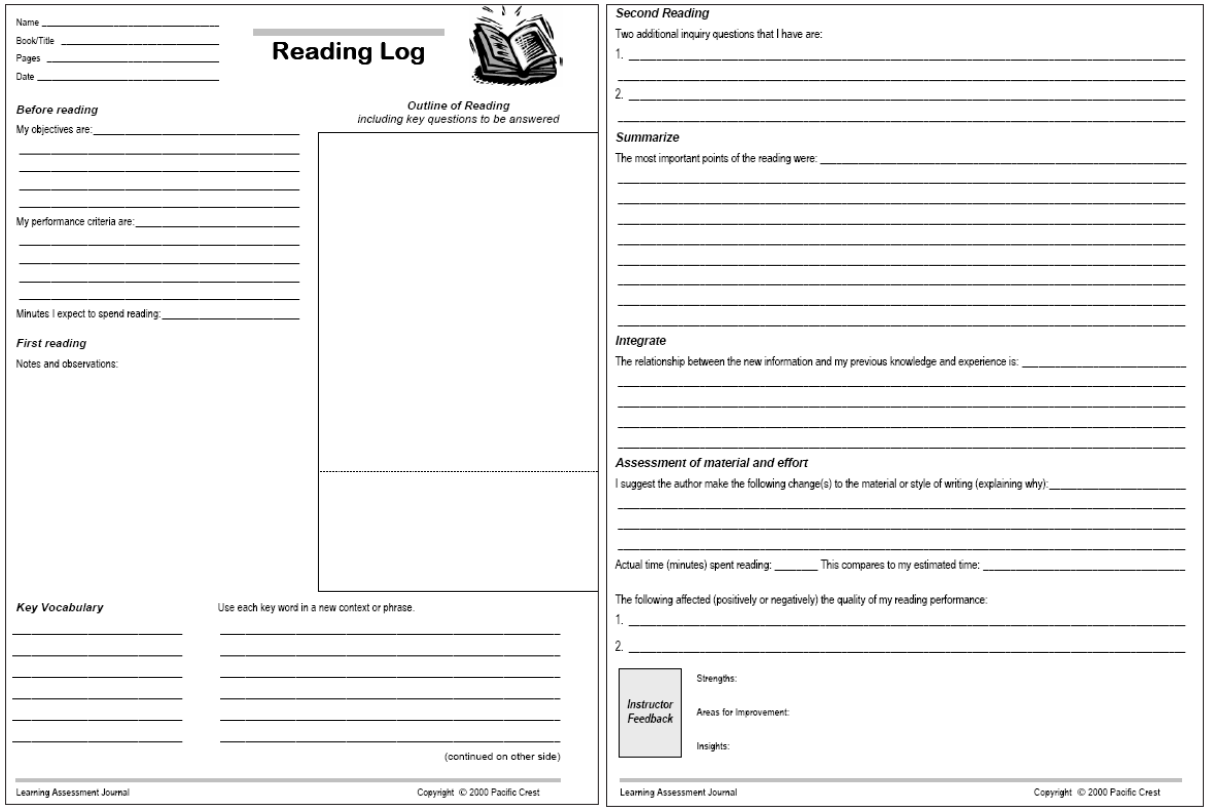
One of the biggest problems faced by students in an upper-level Fluid Mechanics or Thermodynamics course at Kettering University is that students will cover between 400 and 500 pages of text throughout the term to achieve the objectives of the course. Classes at Kettering University last for 10-weeks and in this time there are only 17 class meetings to assign readings in support of classroom content: 20 two-hour classes per term with two mid-term exams. This amounts to approximately 25-30 pages of reading assigned for every class session. The implementation of a reading log system in junior-level Thermodynamics and Fluid Mechanics classes was prompted by anecdotal evidence from students indicating that the text was not being fully utilized.

Observations of widespread textbook sharing and empty desks during in-class references to figures led to a series of discussions during the summer term of 2006 about their textbook usage. In these discussions, many students in the class reported that they only used the text to acquire problem statements for homework or to reference examples for use as templates in solving homework problems. These student comments prompted the development of a formal class survey to assess the extent of the problem. In the fall term of 2006 less than two-thirds of the students had purchased the textbook by the beginning of the second class session. In the spring term of 2007, less than half of the students had purchased the textbook by the beginning of the first class, although the introduction of the reading log and online homework problems requiring a textbook key meant that the entire class had the textbook by the beginning of the second week. At the same time when as the survey was distributed, efforts were being developed to address various content issues related to student retention of material discussed in class and it was decided to implement a reading log assignment as a support tool for the course. While the primary goal for the reading log in these junior-level Fluid Mechanics and Thermodynamics classes was to promote student use of the textbook as a secondary resource, additional goals for these assignments were to encourage reflective thinking, provide an aid to the synthesis of concepts, and challenge student thinking.

The reading log assignment was introduced to two sections of Fluid Mechanics during the spring term of 2007 and has been used in two subsequent terms with over 200 students participating in its pilot and development. The first form of the reading log was a modified version of an example reading log (Figure 1) presented to participants at the Pacific Crest Teacher Institute[7], an event sponsored by the Center for Excellence in Teaching and Learning at Kettering University in January, 2007. This workshop advocated a Process Education approach to undergraduate instruction and the reading log was espoused as one tool for improving student interaction with course content material.

Process Education is an educational model developed by the Pacific Crest Institute promoting performance-based philosophy which emphasizes the continuous development of learning skills to encourage self-learning skills. [8] To support these objectives, the reading log

developed by the Pacific Crest Institute included sections for: recording pre-reading objectives, summarizing the reading, connecting the reading to prior learning, reflection on the reading and reflection on the process of reading.



Name _____
Book/Title _____
Pages _____
Date _____

Reading Log

Before reading

My objectives are: _____

My performance criteria are: _____

Minutes I expect to spend reading: _____

First reading

Notes and observations:

Outline of Reading
including key questions to be answered

Key Vocabulary — Use each key word in a new context or phrase.

(continued on other side)

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Second Reading

Two additional inquiry questions that I have are:

1. _____
2. _____

Summarize

The most important points of the reading were: _____

Integrate

The relationship between the new information and my previous knowledge and experience is: _____

Assessment of material and effort

I suggest the author make the following change(s) to the material or style of writing (explaining why): _____

Actual time (minutes) spent reading: _____ This compares to my estimated time: _____

The following affected (positively or negatively) the quality of my reading performance:

1. _____
2. _____

Instructor Feedback

Strengths:

Areas for Improvement:

Insights:

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Figure 1: Reading Log from Pacific Crest Teacher Institute [7]

The difference in form between the example reading log and the pilot version was prompted by a work-load/self-evaluation to determine the amount of time that would be required for students to complete the reading log in addition to the reading. During this self-evaluation it was quickly discovered that the space available on the sample reading log for student comments and equations was far too limited for its implementation in an upper-level Engineering class. In a typical 30 page reading the students could encounter a large number of equations, some used for development of the material and others central to the course. If the class had daily reading assignments rather than twice weekly assignments then example reading log would probably have sufficed in the example form.

As a result of this initial evaluation the example reading log was extended to three pages, explicit instructions were added to the format and a larger area was developed to include space for key formulas and a description of their use in a problem. In this way it was hoped that the students would either step through derivations and identify the reasoning for each step or use the space to summarize the large volume of equations present in a chapter. The last page of the revised reading log contained the same reflective questions that were present in the example reading log.

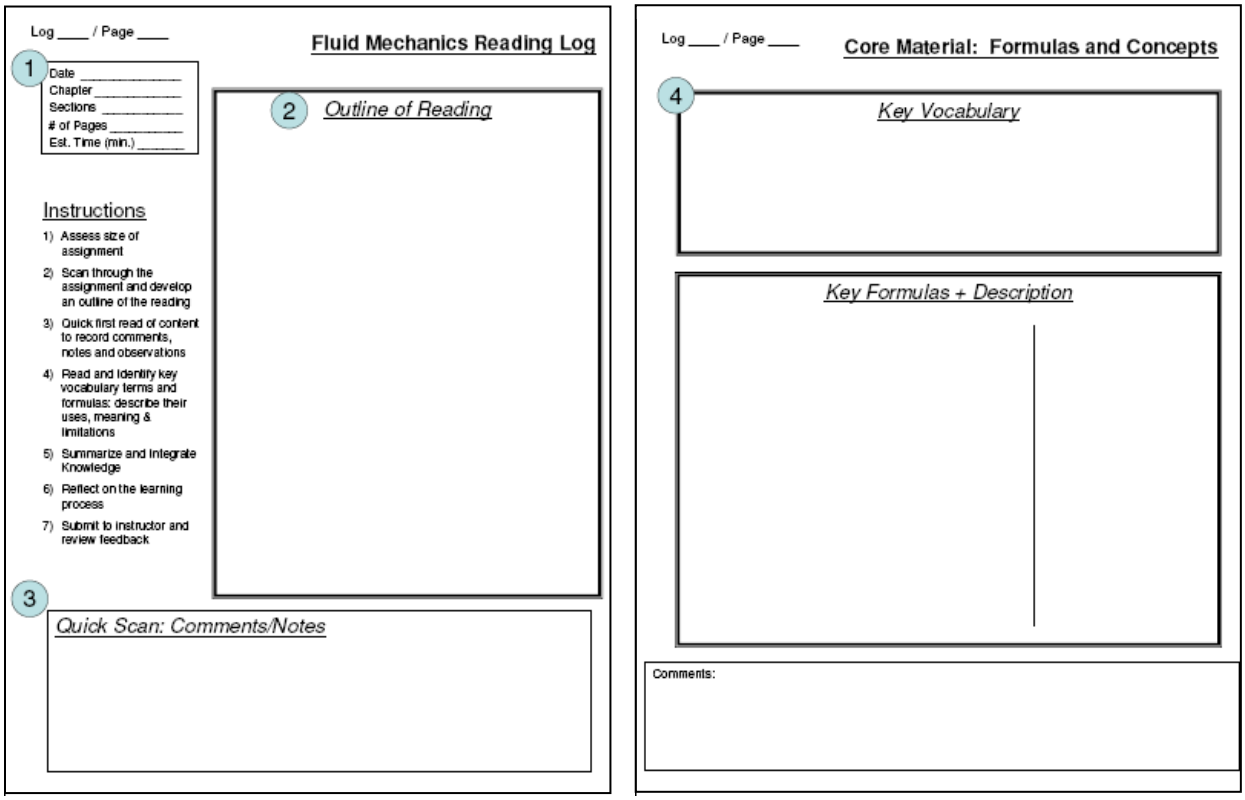


Figure 2: Preliminary Reading Log (first two pages only) – Spring 2007

Evaluation of Initial Reading Log

The pilot version of the reading log was assigned on a chapter basis in the spring term of 2007. The assignment was assessed (reviewed and commented, but not graded) three times during the term and evaluated an additional three times. During these assessments and evaluations, two things were observed as being significant. The first was that student responses on the reading logs were often limited to lists of equations, despite the structured format that encouraged exploration and synthesis of knowledge. When students did complete the reflective thinking portions of the assignment, their answers were often curt or limited to bullet points. Verbal descriptions of the equations or conditions of their use would be included when specifically requested but, by and large, the student responses were terse. The second observation was that many of the students had a hard time themselves completing the reading logs at all. Students expressed on surveys that the reading logs took between 2 and 4 hours to complete and that, along with the homework problems, they simply did not have enough time to devote to the assignment. At the conclusion of the term, student attitudes and opinions on the reading logs were surveyed and a summary of their work was reviewed. From this evaluation of the process, the following points were identified as areas requiring attention:

1. Students were bored with the repetitive structure of the reading log and felt that the assignment was tedious.
2. Students avoided the pre-reading elements.

3. Students avoided the reflective elements of the reading log and felt that they were pedantic.
4. Students felt objectives of the assignment were unclear.
5. Students were focusing on equations and not on the conceptual elements.

Revision of Reading Log: Progressive Reading Log

During the summer term of 2007 it was decided to revise the reading log format to address the many issues that were uncovered during its initial implementation; the main issue being that the students appeared to need guidance in developing the self-learner skills encouraged by the reading log process. This revised reading log would change form over the course of the term to assist students in recognizing key concepts and to teach, by example, how to dissect or identify important elements from a written text. As such, the form of this reading log would progress over the course of the term from a worksheet format where students would be asked specific questions about the content of the reading assignment to a completely unformatted and self-determined structure by the end of the term. This varying format would also aid in alleviating the tedium factor that students had previously reported.

Early in the term the reading logs were essentially worksheets prompting students to collect information on the textbook for various central concepts (Figure 3). Homework style questions were interlaced with content identification to provide students with opportunities to use the knowledge gained and to challenge students on their understanding of the definitions. In this manner the reading log/worksheet modeled exploratory behaviors and the asking of "what if" that is essential to science. Later in the term the reading log was still focused on guiding the student towards the identification of the central concepts and underlying meaning of the material (Figure 4), but the shift is to higher order thinking and manipulation of the material through open-ended questions and the inclusion of problems to illustrate the concepts.

Finally, as the end of the term is approached and the students have had considerable practice at deciphering the textbook to determine key points, the initial form of the reading log was introduced to the students. As in the first term of the reading log implementation, the responsibility was on the student to read the text and determine what was important for inclusion on the reading log. Then, in the last few weeks of the course, the students were given an open-ended assignment where they were told to generate their own reading log for the material.

Evaluation of Progressive Reading Log

Student performance on the worksheet style reading logs was, by and large, excellent. With the worksheet format, students had discrete objectives and the familiarity of the assignment meant that they were able to jump right in to the process. They also had a definite product at the end of the assignment which they could compare, correct and discuss with their peers or in class. For example, with the material illustrated in Figure 4, the students were repeatedly asked to define a sign convention used in the textbook and to generate tools to demonstrate their understanding of the reasons behind the convention. Their responses to each of these questions could be reviewed during discussions and revised if they were found to be incorrect. The cyclical question on the nature of work at the end of that worksheet also served to guide students towards a revision of their initial definition for the concepts of work and energy.

Reading Log: Worksheet (Chapter 2)

Systems and Control Volumes

Define the following terms:

Control Volume

Control Mass

Closed-System

Open-System

In your own words, explain the difference between "intensive" and "extensive" properties.

Identify whether each of the following is an "extensive" or "intensive" property:

Density (ρ)
Energy
Temperature
Melting Point

Momentum is an "extensive" property – what is it's "intensive" counterpart?

Figure 3: Introductory Section Reading Log (Thermodynamics)

Reading Log: Worksheet (Chapter 4, Sections 4.1-4.4)

Work and Energy

Define the following terms:

Work:

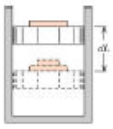
Energy:

Work done **BY** a system is (+) or (-)

Work done **ON** a system is (+) or (-)

Explain, as if to an introductory Physics student, why this sign convention is more than just arbitrary. (i.e. explain the physical meaning for such a sign convention)

Hint: discuss the impact on the energy of the system in each case



A Bunsen burner is placed under a piston-cylinder system. The volume of the gas increases from 0.03 cm^3 to 0.07 cm^3 and the pressure remains constant at P.

Determine the amount of work that was done in this process.

Is the sign of the work done in this process (+) or (-) ?

Revise your definition of work so that it does not contain the concepts of 'force' or 'distance'.

Figure 4: Selections from a Middle-Term Reading Log (Thermodynamics)

When the self-developed reading log assignment was reached near the mid-point of the term, students typically returned to the process of simply identifying key equations. In this respect they had only limited success with the assignment since the material in both the Fluid Mechanics and Thermodynamics classes tends to be thick with equations in the latter parts of the course. A number of students, however, were able to connect the equations with insightful and meaningful statements. This can be seen in Figure 5 where the student took the time to summarize the purpose of the chapter and to identify conditions for important fluid flows. This is also evidenced by the student's written definition of vorticity, although this student does not take the opportunity to elaborate on why the factor of ½ originally appeared in the definition of the rotation vector.

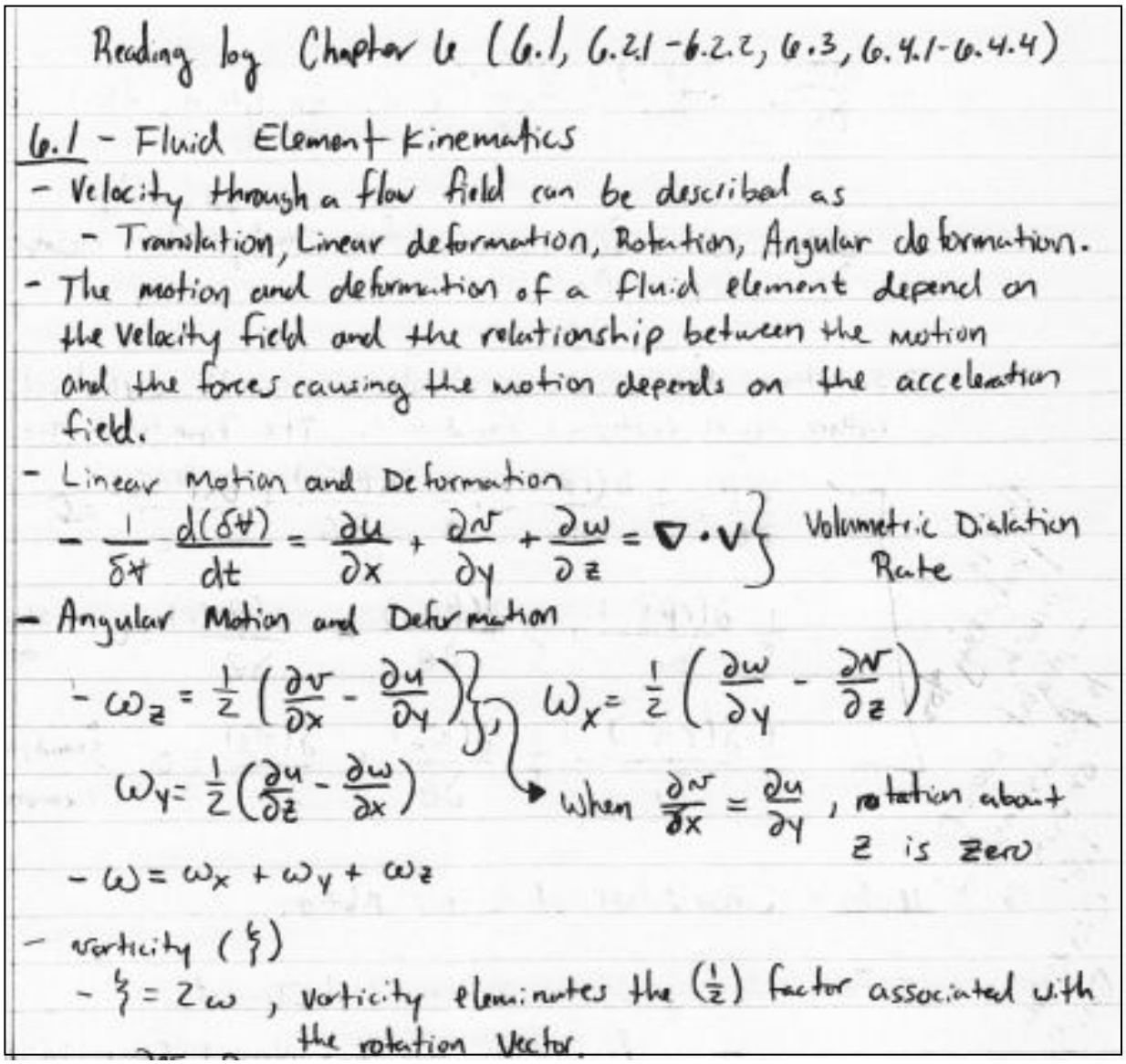


Figure 5: Example of Student Work – Mid-Term Fluid Mechanics Assignment

Later in the same assignment, however, it was clear that the student was also operating on automatic when it came to listing and describing the equations from the chapter (Figure 6). In the first introduction to the concept, the students were told to avoid all but the Cartesian form of the equations and the section containing the equations in cylindrical coordinates was omitted from the assignment. As the comment on the student's reading log indicated, the equations by themselves would have little meaning without an example or guide to their use. Even so, the student did include tags to indicate the conditions applied on using each of the equations.

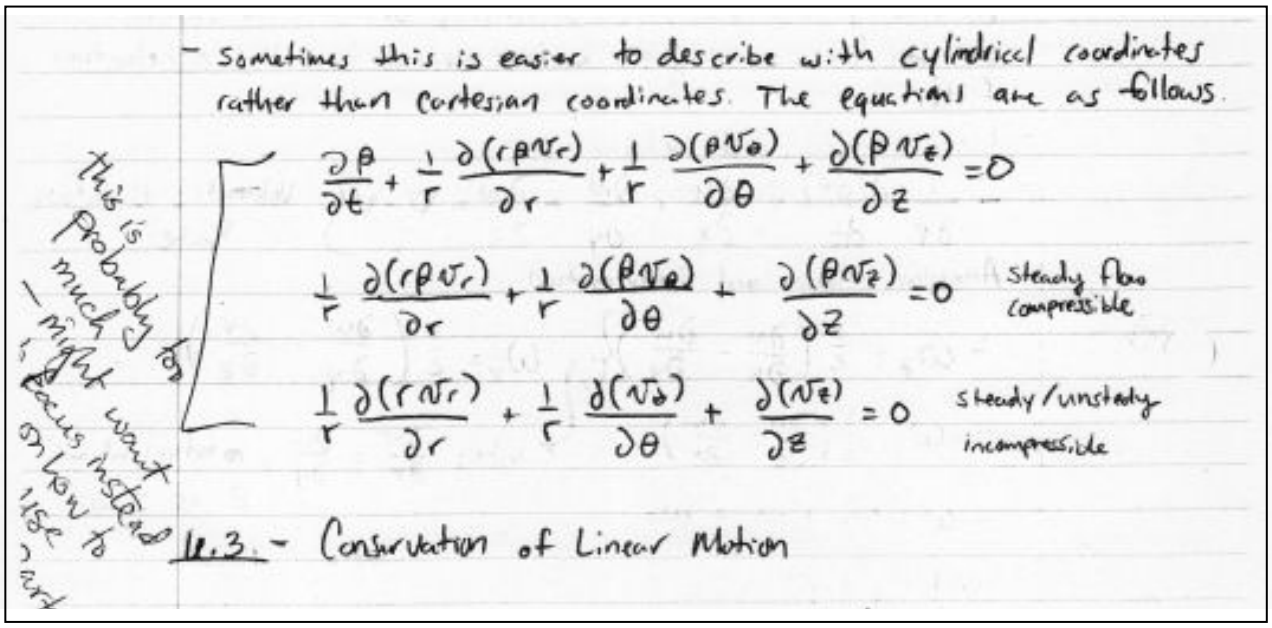


Figure 6: Example of Student Work – Mid-Term Fluid Mechanics Assignment

Conclusions

One of the greatest benefits of the progressive reading log format is that it permitted the transfer of some of the teaching load from the classroom to the homework assignments. By shifting the load to the students for some central concepts and by guiding their exploration of the topic, students could be steered towards various observations on the material. The inclusion of open-ended questions and observations reinforced their understanding of the text and ensured that no one would be left behind or without a resource, provided that they completed the assignment.

For example, with the concept of specific gravity in Fluid Mechanics the use of the reading log to focus student homework efforts on this topic removed from the class lecture the need to motivate, introduce, discuss and conduct an example problem. In addition, the assessment of the concept in the following class session (necessary because specific gravity is central to the course) also served to reinforce the importance of the reading logs throughout the term since the act of actively completing the reading log meant that the follow-up quiz was trivial for the student. By shifting the responsibility for the content from the instructor to the

student, approximately 20 minutes of classroom time were recovered and could be used to strengthen more difficult concepts later in the unit.

Student response to the progressive reading log format was generally positive. Out of the 41 students surveyed in a follow-up questionnaire on the introduction of the reading log, only three students indicated that they would not have needed the reading log assignment to pass the quiz. Of the remaining 39 students, only two felt the reading log was unnecessary and one complained that the reading log took an excessive amount of time (2-3 hours) to complete. The difference in the perception of the work load between the first implementation of the reading log and the implementation of the progressive reading log is attributed to the structure present in the early stages of the progressive reading log. With definite outcomes and expectations, students were clear when the assignment was finished and they understood the depth of understanding that was required. As the term progressed and the reading logs were more self-directed, students had 5 weeks of activity on which to base their efforts. Positive comments from the rest of this group indicated that the reading log helped them "focus their study" and "reinforce the central concepts" contained in the reading assignment. Those students that failed the quiz indicated on the survey that they did not do the assignment but that they felt that the reading log would have helped.

Another key outcome of the progressive reading log is that, in a worksheet format, it has permitted the instructor to challenge student understanding outside of the classroom on a number of concepts. Tools such as guided questions and revisiting connections to previous content have allowed the worksheets to be dynamic resources for students. This approach also serves to prevent the reading log from becoming formulaic. The greatest challenge in development the progressive form of the reading log, however, is that the instructor needs to be intimate enough with student learning and how students respond to the specific concepts so that the questions could anticipate student troubles, align the content with student interests and connect the students with the material.

The development of the progressive reading log still faces several challenges and there are a number of areas for improvement. The first being a direct assessment of both the local and long-term influence of the reading log on student learning. To address this, a coordinated effort with other sections, taught by different faculty, is planned so that pre- and post-assignment questionnaires can be distributed to probe student understanding of concepts and evaluate student textbook use. Another focus area for the development of the reading log is the transition to the self-constructed reading logs. Within the reading log format, tools need to be developed to assist students in both deciphering the volume of equations and attaching meaning and guides to use for those equations. In the end, however, it has been observed that with the reading log assignment the main objectives have been achieved and students have been using their textbooks as a secondary (and, in some cases, primary) resource.

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