Fast Formative Feedback using Muddiest Points and Just In Time tools in Engineering Materials courses

Prof. William Joseph Stuart P.E., Oregon Institute of Technology

BIOGRAPHICAL SKETCH

Professor Joe Stuart

PROFESSIONAL PREPARATION

B.Sc., Metallurgical/Mechanical Engineering, University of Nevada at Reno (1969) M.Sc., Physical Science, University of Southampton, UK (1972)

APPOINTMENTS

2006 to Present Program Director Manufacturing Engineering Technology, OIT 2011 to Present Associate Professor, MMET Department, Oregon Institute of Technology 2004 to 2011 Assistant Professor, Oregon Institute of Technology, Klamath Falls 2002 to 2004 National Accounts Manager, Wagner Electronics 1998 to 2002 President/Owner, Best Tech USA 1985 to 1998 VP and General Manager, Alumaweld Boats Inc & Rogue Trailers Inc. 1984 to 1985 Manufacturing Rep MDA Associates 1981 to 1984 Quality Engineer, International Memories Inc. 1980 to 1981 Design Engineer Balteau Standard 1977 to 1980 Field Engineer, Wisar Construction 1975 to 1977 General Manager Milthorn Toleman Ltd., UK 1974 to 1975 Chief Scientist, Puerto Rico Nuclear Center 1972 to 1974 Engineering Consultant, EPA 1969 to 1970 Metallurgical Engineer, Republic Steel Inc.

Professional Societies:

American Society of Engineering Education, Life time member Society of Manufacturing Engineering, American Society of Mechanical Engineers

PUBLICATIONS

(i)Most Closely Related [1] W.J. Stuart 'Problem Based Case Learning - Composite Materials Course Development – Examples and classroom reflections' NEW Conference, Oct 2011 [2] W.J. Stuart and Bedard R. (EPRI) 'Ocean Renewable Energy Course Evolution and Status' presented at Energy Ocean Pacific & Oregon Wave Energy Trust Conference, Sept. 2010. [3] W.J. Stuart, Wave energy 101, presented at Oregon Wave Energy Symposium, Newport, OR, Sept. 2009. [4] W.J. Stuart, Corrosion considerations when designing with exotic metals and advanced composites, presented at Corrosion Conference of Exotic Metals, Park City, UT, 2009. [5] W.J. Stuart, Ruth Loring, Ed Webster, Frank Cox, Composite materials course development using problem based case learning techniques, National Educators Workshop, Greensboro, NC, 2009. [6] W.J. Stuart, Three pronged approach to sustainability at OIT, presented to faculty and staff at OIT 2008 Fall Convocation, 2008. [7] W.J. Stuart, Sustainability workshop, presented to faculty and staff at OIT 2006 Fall Convocation, 2006. (ii) Other [1] W.J. Stuart, Successful programs that have been enriched by industry and engineering education connections, Proceedings of ASEE Conference, Chicago, IL, 2006.

SYNERGISTIC ACTIVITIES

• Course development for Ocean Renewable Energy for Manufacturing Engineering Technology and Renewable Energy Engineering students: developed and taught a new undergraduate dual listed course, Ocean Renewable Energy, in spring 2010. This course has now also been developed and is offered (and has been taught) as a 'Distance Education' course. • Course and lab development for Advanced Composites for Manufacturing Engineering Technology and Mechanical Engineering Technology students: developed and taught a new undergraduate dual listed course, Advanced Composites, in spring 2009 and winter 2010. • Student advising and course integration in sustainable concepts and life cycle analysis and material selection considerations. • Innovations in teaching: used innovative teaching methods to enhance the learning experience through introducing problem based case learning techniques in classes and course structure; presentation of paper in National Educators Workshop.

COLLABORATORS AND OTHER AFFILIATIONS

(i) Collaborators and Co-Editors Frank Cox, Edmonds Community College; Ruth M. Loring, Nashville State Community College; Wangping Sun, Oregon Institute of Technology; Ed Webster, Institute for Professional Training and Education; John Anderson, Oregon Institute of Technology

(ii) Special Material Expert Curriculum development for National Resource Center-CAM composite materials course for National Resource Center at Edmonds Community College.

Ms. Natalie Rachel Sheffield, Oregon Institute of Technology

Title: Fast Formative Feedback using Muddiest Points and Concept Warehouse tools in Engineering Materials courses.

Abstract:

'Just In Time Fast Formative Feedback (JTF)' is a National Science Foundation (NSF) grant that incorporates the use of 'Muddiest Points', survey data collection, and other tools; in several engineering material science courses offered at Oregon Institute of Technology. The 'Just In Time Fast Formative Feedback' project is in collaboration with several other colleges, including Arizona State University, Oregon State University and North Carolina A&T. The purpose of JTF is to encourage fast response to students misunderstanding of material. One of the key elements is 'Muddiest Points', which is a survey presented to the students in the classes on a weekly basis to collect what topics within that week's lecture were challenging to understand, or that the students wished to learn more about. The survey information is added to a database in order to compile the topics which need to have more time for clarification in class. This presentation will discuss and provide examples of collecting the Muddiest Points using surveys and other tools.

The Material Science courses which data is collected for this project are currently taught at Oregon Institute of Technology at both a freshman and junior level undergraduate engineering classes. For these classes, the implementation of 'Just In Time Fast Formative Feedback' is proving to increase student engagement, retention and subject knowledge as they are increasingly applied over several terms of teaching these courses. This application will also show that the techniques not only become easier but also more effective as they evolve with each new term of applying them. This paper will also address the steps involved in developing and using the tools and some methods of making this process user friendly to both the students and the instructor.

JTF NEED:

Engineering students studying 'Material Science' have to struggle when learning new concepts, how they might apply them in the real world design challenges as well as learn a new language, the language of 'Material Science'; this language includes the vocabulary of material selection techniques, manufacturing processes and much more. This learning process is particularly demanding for students with a heavy load of engineering coursework. The most rapid and efficient way for students to learn this is to provide repeated explanations of the material that is confusing or misunderstood as quickly as possible. This teaching style is, 'Just In Time Fast Formative Feedback' or JTF. JTF helps the information get transferred from the students' short term memory into their long term memory.

JTF METHODS:

Over several years, Oregon Institute of Technology and other collaborating Universities have developed some instructional methods while working on a National Science Foundation (NSF) grant incorporating the 'Just In Time Fast Formative Feedback'. These methods were applied in 100 and 300 level 'Materials Science' courses for engineers and engineering technology undergraduate students. One of the most effective techniques has been what is referred to as the 'Muddiest Points', which is the collecting of the most unclear parts of a class lecture, and then clarifying them using several supportive methods as quickly as possible.

In the first term of implementing the Muddiest Points method, surveys were collected during class from a hard copy questionnaire; while during the second term, the Muddiest Points were collected online after lecture using Concept Warehouse. The first term, since the questionnaire was handed out during lecture, there was a 100% response rate from students in the lecture that day (which for class attendance meant an overall response rate of 94%), while the second term, there was an average of 14.7% response rate.

For future classes, the first style of surveys will be used, as it was found to be most effective. It is explained as follows:

When a class begins, a short questionnaire is distributed to the students and they are asked to fill it out during the last 5 minutes of class, after the lecture has been presented and discussions have finished. The students will each describe what is not clear in their "Muddiest Point" (or 'Muddiest Points') in usually one or two sentences. Additionally, they answer what was the 'most interesting point' so that the professor can get a better understanding of what is not well understood and what is found to be enjoyable (and probably most clearly understood.) These questionnaire surveys are then collected at the end of each class and reviewed to get an understanding of what items most needed to be clarified before moving on to new topics.

TOOLS:

1) PowerPoint slides at the start of the next lecture: One of the easiest ways to address these 'Muddiest Points' is to create one or two PowerPoint slides that explain the topic in question. It seems to be better to explain the Muddiest Point in a somewhat different manner than was done in the initial lecture. It also seems to have more impact if a student, a teaching assistant or someone other than the original lecturer delivers this clarification. There are several ways to accomplish this. A student who has correctly answered or described the topic in previous classes as a homework item can perform the

review. A teaching assistant can perform the review and it has been found to be beneficial to record these or at least have the teaching assistant provide a set of 'narrated PowerPoint Slides' so that the slides can be collected in a data bank and used for future classes. Students engage and are very responsive to hearing these reviews from other students.

2) Videos: At first, a couple of videos were used from 'Muddiest Points' collection on 'YouTube', but it was found that the explanations lose impact if they are too long. For best results, if videos are used to help clarify a topic, it should be limited to two to five minutes in length. If there is something that is very complex then iy can be stretched another minute or two, but generally no longer than five minutes total.
   Our team is now working on expanding a database of brief videos that we can all pull from to clarify the 'Muddiest Points'. These can be made right in the classroom with a student or teachers assistant as the lecturing person giving a PowerPoint explanation. If the video is focused and on point then this method is very effective.
   Another tool that the team is planning on incorporating into their JTF project is a Pencast. A Pencast is a 'smart pen' that connects with a computer so that live explanations can be recorded as hand written and orally explained. These recordings can be used repeatedly for efficient use of explanation time, and can be converted to video format and posted on YouTube and Blackboard. The cost to purchase a Pencast tool is less than $200.
3) Concept Warehouse[1]: This website is a collection of many concepts and their description. Concept warehouse is constantly expanding as many different sources are contributing to it. It has some very useful features that help it to be a useful learning tool. Concept Warehouse also has a testing option, which can be run either during class or outside of class.

   Concept Warehouse was not found to be an efficient method for Oregon Institute of Technology. It did not work well for collecting the 'Muddiest Points' because most students do not have laptops, tablets or smartphones that they can bring to lecture on a daily basis. In addition, many of the students commented on how challenging it is to use.

4) Quizlet[3]: Quizlet is designed to aid students in their studying. It's set up for explanations and pictures to be linked to topics of importance. A professor or teacher's assistant can create a database of terms, topics that correlate to each chapter. One built-in tool on Quizlet is the ability for it to generate tests. When generating a test, the testing options include written, matching, multiple choice, true/false, or any variation of them, and then the ability choose the number of questions which are to be incorporated into the test.

JTF BENEFITS:

Student engagement: One of the fastest and most rewarding benefits of using the JTF tools in the classroom is the significant increase of student involvement in discussions which leads to students of all caliber answering reflective questions and making solid attempts at solving problems. This is because these tools give all students an increases understanding of the core concepts which in turn increases their confidence and involvement in open discussions. This process needs to be carefully coached with studnets experiencing encouragement and success in their attempts to answer questions posed by the instructor. The instructor must also pose well thought out questions to the class that coincide with the JTF reiterations and the solutions that have been reviewed using the JTF tools. At the end of each term of implementing the JTF style of teaching, the students were given a survey on 'Muddiest Points' and whether felt 'Muddiest Points' was beneficial to their learning. The student's responses are displayed in Table 1.

Table 1: Survey of Students Collected at End of Each Term

Students Opinion:	**Spring Term 2013**		**Fall Term 2013**	
The "Muddiest Points" Daily Reflection Used in this Course…	**Agree:**	**Disagree:**	**Agree:**	**Disagree:**
Was an effective way to increase my engagement in the course.	76.5%	23.5%	77.8%	22.2%
Helped me better understand my own learning.	61.8%	38.2%	78%	23.5%

Retention: Our team has tracked via the 'Muddiest Points' questionnaire how many students have been retained in the class from the second week of term to the final week of term. There seems to be a consistent with a retention rate of over 90%. This is compared to data from earlier classes before JTF was implemented, that illustrated a retention rate of 75 to 85%. See Table 2. During Spring 2013, there was a weekly attendance collected and the overall daily attendance was never below 80%. See Figure 1.

Table 2: Retention Rate of Students

Term:	Fall 2012:	Spring 2013:	Fall 2013:
Percent of Students To Complete Course:	81%	92%	92%

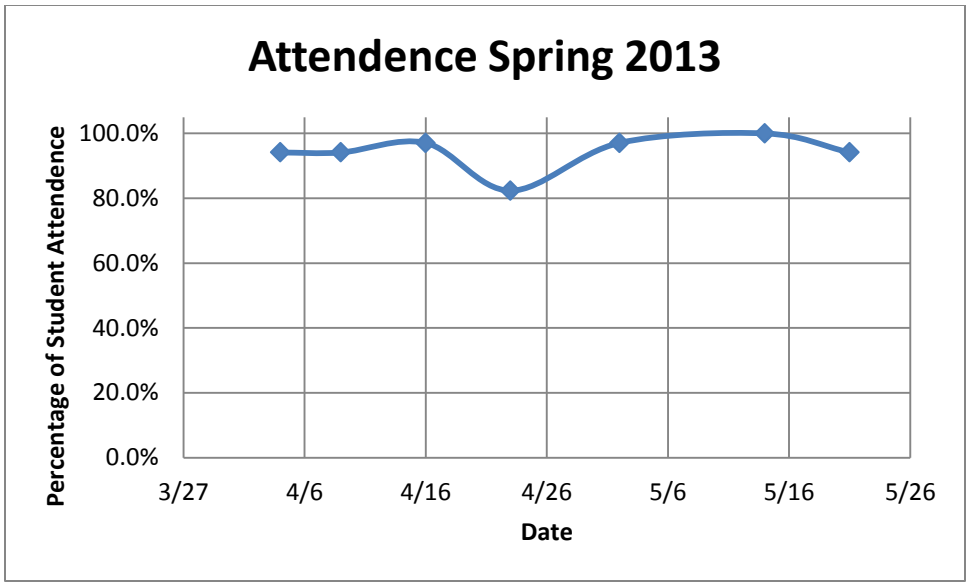

Figure 1: Attendance for Spring Term 2013

Subject Knowledge: Students gain knowledge faster and grasp concepts quicker if JTF tools are used efficiently. An important part of this is that the instructor must explain all of the tools very carefully and thoroughly. This is important for both the student understanding of and their trust in the system. Another item for the instructor to monitor closely is to pay attention to how all of the students are doing. It is extremely important for the instructor to read all of the 'Muddiest Points' as well as all of the most interesting points so that a careful and representative response can be given to the student input. It may take extra time to do this, however it is evident that it helps students to have a better understanding of the subject material and to develop a better grasp of some of the more difficult concepts, such as precipitation hardening, glass transition temperature and the use of phase diagrams. Again, this is because these more complex ideas are reviewed in depth, reviewed several times over a short time frame and then assessed and reinforced through reflective discussions and, finally, tested in homework and exam questions. From the same survey of students at the end of the term, from Table 1, the students were asked if they felt that the 'Muddiest Points' assisted them in being successful in this course. The students responses were more than 60% positive both terms. see Table 3.

Table 3: Survey of Students at the End of Each Term

Students Opinion:	**Spring Term 2013**		**Fall Term 2013**	
The "Muddiest Points" Daily Reflection Used in this Course…	**Agree:**	**Disagree:**	**Agree:**	**Disagree:**
Helped me to be successful in this course.	73.5%	26.5%	66.7%	33.3%
Decreased my interest in the Content of this Course.	11.8%	88.2%	0.0%	100%

Test Scores: Test scores, along with the student team PowerPoint presentations, analyzed each term illustrate that there is a higher level of understanding of the course material as well as an increase in the confidence level as the students talk about some of the more challenging concepts. New quiz and test questions were accessed and framed by using Concept Warehouse and Quizlet which meant that questions don't become stale and these challenge the students in new ways. The final grades for the last several terms when using JTF techniques have improved in both average score level and higher grades earned by students, thereby shifting the bell curve to the right. See Table 4.

Table 4: Final Grades by Term

	A	B	C
Fall 2012 (Before JTF Implementation)	41%	35%	24%
Spring 2013	53%	44%	6%
Fall 2013	47%	47%	6%

Ease of learning: Students have expressed in a final class survey that they found learning easier with the implementation of JTF tools. One of the interesting outcomes is that the students have expressed that they enjoy learning from the instructor as well as having some of the reviews done by the teacher's assistant. It seems to be a strong combination to first teach the material, then reinforce it using another student, finally having them put the explanation in the students own words. One future goal of this project is to develop a database of short student made videos illustrating 'Muddiest Points' reviews.

JTF CHALLENGES:

TECHNOLOGY: The lack of students with laptops or tablets that they can bring to class limits the available resources that can be used during lecture. The constantly new and improved equipment on the market for making videos and other support information is sometimes challenging to learn to use and expensive to buy.

TIME: Implementing JTF does take more time both in the classroom and in preparation time by the TA and the instructor. A teaching assistant can make a large difference in the process and thereby save the instructor a lot of this preparation time. Once the process is setup, (especially if using Blackboard) then additional time is greatly minimized.

RESOURCES: If you are using 'Pencast' there is an upfront cost as indicated, as well as the cost of the time to create the Pencast explanations. However, once these are organized and filed they become a readily accessible resource for future classes.

JTF FUTURE:

In the future, Oregon Institute of Technology will continue its JTF projects by making short videos using different styles and looking into other forms of collecting information from the students.

Since making videos is currently time consuming and laborious, one of the prospective upgrades is using 'Pencast'. The explanations created using Pencast can be developed and put into a database for in-class explanations as well as Blackboard and online collections for students to study on their own time. Our team sees this upfront work as necessary in order to reap benefits for future class efficiency.

Surveying students' 'Muddiest Points' can also be time consuming, so making the process efficient is very important. One option would be the use of laptops, smart phone and tablet applications for immediate feedback in the classroom. The challenge here is that all students need to have this equipment.

Data assembled from the classroom questionnaires can help to assess the effectiveness of the 'Muddiest Points' and other JTF exercises. This data over a longer time frame could easily be used to guide the course content and the content of the 'Muddiest Points' video and response database.

As the students become more familiar with the use of JTF concepts, they will have the opportunity to start to incorporate these techniques into their own peer to peer presentations and discussions.

CONCLUSION:

'Just In Time Fast Formative Feedback' (JTF) teaching techniques are a fast and efficient way to explain topics that are a challenge for students to understand. The methods start by determining what is not clear and then progressively reinforcing solutions as quickly as possible in a prioritized fashion so that understanding is solidified. JTF has been used in sophomore and junior level engineering materials science courses at Oregon Institute of Technology and it has proven to increase the knowledge gained by the students, student retention, student engagement as well as exam scores and final grades in these classes. It has become very apparent that this collection of JTF teaching tools and techniques can be used in many courses to better prepare our students and enhance their learning experience. With the many available resources; expanding the material available to students is very important. With more research and time, the foundation of material available to students and instructors will increase, ensuring increased academic success.

References:

Blackboard. Blackboard Inc. 2013. Web. 21 Jan 2014

AIChE Concept Warehouse. Oregon State University, 2014. Web. 15 Nov. 2013

Pencast. LiveScribe Inc., 2013, Web. 5 Jan 2014

Quizlet. Quizlet. 2014. Web 6 Jan 2014