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Implementation of Active Learning Method in Transportation Engineering Seminar Course

Case Study at San Diego State University

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Abstract — The challenges of retiring workforce, attracting new students, and high educational requirements for dealing with transportation systems complexities have been highlighted in the past decades. In response, transportation engineering (TE) education has been developing both curricula and teaching practices. However, the need for further development and implementation of active learning techniques remains, especially with regard to specific learning context of the graduate level education. The meaningful implementation of known active learning techniques can make effective use of opportunities arising from information-communication technologies. In particular, this research focuses on development of writing-based in-class activity in a seminar graduate course at San Diego State University. The research builds upon the theoretical framework of learning in engineering education, emphasizing the learner-centered methods. Implementation of in-class activity explains the writing tool deployed and the details of the learning context. Evaluation methodology includes mid- and end-term student survey as well as assessment rubric. Overall, results indicate that this innovation is instrumental in evaluating students' learning in the class, and in helping them with development of motivation and metacognition practices. Concluding implications provide lessons for further implementation and development of active-learning techniques in TE and engineering graduate education in general.

Keywords — *transportation engineering education; learner-centered education; in-class activity; seminar course;*

I. INTRODUCTION

A 2015 joint report released by the U.S. Departments of Transportation, Education, and Labor concluded that “the recruitment and training of new and current workers responsible for the operation, maintenance, and construction of America’s transportation infrastructure is critical to maintaining a system that meets our economic and security needs in the 21st century global economy.” [1] Similarly, the challenges of retiring workforce, attracting new students, and high educational requirements for dealing with complexities related to transportation systems have been highlighted by several other publications over the past decades [2][3][4][5][6][7][8]. Having in mind this context, the requirements for 21st century transportation engineering (TE)

professionals include both breadth of knowledge over several areas as well as in-depth knowledge in a specific area. In response, a significant emphasis has been placed in the past two decades on the development of TE education, offering a widespread range of educational opportunities [9][10][11][12][13].

Besides the development of curricula as a critical aspect for the development of competencies of future TE professionals [12], there have been a series of efforts in developing educational practices. A recent comprehensive review of advances of TE teaching practices classifies them into simulation, visualization, experience- and problem-based learning, and other active learning techniques [14]. Moreover, this review concluded that there is a need to further improve the assessment practices for evaluating changes in teaching practices and student learning [14]. The most recent efforts in TE education range from curricula redesign in transit systems planning [15], training in communication skills [16], service- and project-based learning [17][18], implementation of sustainability concepts in brainstorming activities [19], hands-on problem solving and team-based activities [20], assessment of preconceptions [21], up to the development of educational games [22][23][24].

In addition to these efforts, there is still a need for further development and implementation of active learning techniques in TE education. On the one hand, active learning techniques can be effective in supporting TE student learning, and they are often well-received by students [14]. On the other hand, there are opportunities arising from using information-communication technologies (ICT) for a meaningful implementation of known active learning techniques [5][14]. However, the challenge lies in the fact that technological implementation can be both positive and negative. Thus, making the most out of the technological opportunities requires reflective selecting and implementation of suitable tools [5]. Besides the challenge of developing and implementing active learning techniques, there is a need to focus on graduate TE courses. The reason is that most of the TE education development efforts so far have largely focused on undergraduate courses, which might have some important differences of the educational context. The first set of differences stems from the fact that students attending graduate

courses are not always pursuing practitioner careers, but might also have interest in other careers, such as research. Moreover, students entering MSc or PhD programs might have a range of educational background, not necessarily centered on TE. The complexity of the situation can be increased by the fact that students can frequently enter graduate programs with education from non-US institutions, or having only taken one mandatory TE course during their undergraduate studies [10][12]. Finally, course context can be quite different in graduate courses, especially having in mind the class size, which frames benefits and disadvantages for a range of teaching methods.

Taking into account previous premises, there is a need to focus on active learning techniques in graduate education. In particular, this research focuses on development of writing-based in-class activity in a seminar course. Seminar course is often aimed at providing a common background knowledge and set of skills needed for success during graduate studies, thus having a high importance in the curricula. To this end, the paper is organized as follows. First, the second section explicates the theoretical framework of learning in engineering education and the role of writing-based in-class activities. The third section describes the innovative writing tool, and its implementation in the learning context of a seminar course at San Diego State University. The fourth section presents evaluation methodology, based on a mid-term and end-term survey, as well as grading rubric. The fifth section includes results from the implementation, followed by a conclusive section providing lessons learned and recommendations for further development.

II. THEORETICAL FRAMEWORK OF LEARNING IN ENGINEERING EDUCATION

A. Foundations of Learning

The focus on learner-centered education requires first explicating the theoretical framework of learning in engineering education. At the core of the learner-centered education approach is the idea that transformative learning experience does not happen under any condition [25][26]. Having in mind the context of engineering education, it is important to highlight that there is range of theories of learning, which can be broadly classified into three categories, namely behaviorist, cognitive, and situative [27], [28]. Behaviorist theories consider knowledge as having associations, where learning happens by acquiring and applying associations. Cognitive paradigm considers knowledge as structure consisting of different concepts, where learning means acquiring and using conceptual and cognitive structures. Situative paradigm considers knowledge as distributed among people and their environment. Respectively, learning is considered as being attuned to constraints and affordances through participation in the community of practice. Despite the range of theories, a consensus in engineering education is that one has to seek a theoretical synergy in practice by moving away from the notion that learning is a simple acquisition process based on teacher transmission [29]. On the contrary, learner-centered paradigm acknowledges that students actively construct their knowledge and skills as opposed to being a passive recipient of knowledge. Consequently, in the learner-

centered paradigm, teacher is facilitator of learning instead of purveyor of knowledge.

Focusing further on the learning theories, one has to distinguish between shallow and deep learning [29]. Shallow learning is usually focused on words and symbols used, isolated facts, and items are treated independently from each other. Thus, shallow learning occurs when all you do is memorize what you are reading, rather than trying to understand the underlying argument and its significance. In contrast, deep learning means learning the meaning of and connections of ideas, and thus involves exploration in greater detail, the desire to understand the basic principles, and the ability to develop your own arguments. However, it is important to highlight the importance of knowledge structures for learning, as students cannot learn if they have not reached a particular level of development, and if the information does not makes sense to the existing mental structure [29]. In addition, the knowledge structure must be socially acceptable, as identity and social context are also very important for learning [27][29]. Finally, another important aspect of learner-centered education is focus on self-regulation or metacognition, which refers to the degree to which students can manage aspects of their thinking, motivation and behavior during learning [30]. Thus, learning methods that focus on metacognition engage students to actively monitor their learning and reflect on their performance.

In addition to the above features of learning activity, it is important to understand learning as a process. One of the most frequently used models of learning process is Kolb's learning cycle [29]. Kolb's model (Fig. 1) starts with two orthogonally positioned dichotomies. The first dichotomy is between active experimentation (AE) and reflective observation (RO). This dichotomy refers to how individuals prefer to transform experience into knowledge. For example, those individuals who favor active experimentation prefer to get things done and see results. On the contrast, reflective observers prefer to examine ideas from several angles and to delay action. The second dimension in Kolb's model is the dichotomy between abstract conceptualization (AC) and concrete experience (CE). This dimension distinguishes between how an individual grasps information. For example, abstract conceptualizers prefer logical analysis, abstract thinking, and systematic planning, while individuals who favor concrete experience prefer specific experiences and personal involvement, particularly with people, and tend to be nonsystematic. Kolb's model allows one to understand the importance of activities and interaction for learning, as well as material context of learning [27][29]. A proficient learner is able to complete all steps in the cycle although she prefers certain modes of operation. The cycle can be entered at any of the four steps, but usually starts with the concrete experience method of grasping information. Requiring more active involvement by students increases learning because additional stages in the learning cycle can be used. A lecture that focuses on reflective observations from many viewpoints can be supplemented by requiring students to think about the ideas for abstract conceptualizations. In contrast, out-of-class activities, such as assignments or fields trips can focus more on active experimentation or concrete experience.

Fig. 1. Modified Kolb's Learning Cycle [26]

B. Active Learning and In-class Activity

In this context of learning theories, learner-centered paradigm emphasizes that people do not learn well when their major learning context is teacher-centered, i.e., when they passively listen to a teacher talk [31] [32]. The reasons for active learning range from simple cognitive constraints on attention span if the brain is in a passive stage over longer periods, up to the questions of metacognition. In contrast, students have to be engaged in ways beyond listening, as lecturing may succeed at promoting short-term factual recall, but often fails at promoting long-term retention of information, comprehension, problem-solving skills, and motivation [31][33]. Active learning can involve a range of methods, from answering to instructor's questions to group problem-solving, thus engaging students in practice and reflection activities [31][32][33][34][35][36][37]. Consequently, active learning approach emphasizes the nature of learning activities that student uses. In particular, high emphasis is placed on learning activities that involve frequent in-class assessment. These activities are sometimes referred to as formative assessment when they are focused on shortening the delay between students' activity and provision of information about student's performance. Thus, these in-class assessment activities can enable teacher to make timely course modifications according to student's development [29][38][39]. However, going beyond the narrow conception of formative assessment, the first advantage is that the in-class assessment process itself involves greater cognitive processing through engaged practice [40]. Second, assessment activities in general play a significant role in students' expectations, external motivation, and fostering metacognition [38]. As Biggs states: "What and how students learn depends to a major extent on how they think they will be assessed." [41] Third, in addition to providing feedback to student and teacher, in-class activates and their respective assessment have a dialogic role, providing an opportunity for discussion between student and teacher on the learning process [38]. This is especially important considering the influence that frequency and quality of student-teacher interaction has for students' learning [42].

Following the general idea of active learning as learning in doing, there is a range of potential in-class activities that instructors can use [43]. All these techniques need careful implementation as effects can be both constructive and inhibitory for learning [38]. Here, this research focuses on writing, as a mental process that can activate deep learning mechanisms through mutual reinforcement and development [41][44]. Writing provides a comprehensive and specific approach into thinking processes, providing evidence for presence or absence of thoughts. Moreover, writing can provide clear evidence of knowledge, especially in curricula that might otherwise be focused on analytical methods, as is often the case with graduate TE courses. The technique implemented in this research draws inspiration from classroom assessment technique called attention retention quiz, which asks students about lecture content [45]. The results from this previous implementation have shown that 96% of students found that quiz has helped them keep their attention, 95% felt that it helped with retention of information, and 88% perceived that it helped with their understanding of course content. The following section will describe the details of the in-class activity implementation.

III. IMPLEMENTATION OF IN-CLASS ACTIVITY

A. Writing Tool

The innovative writing tool used in this study is named "Write or Die". As shown in Fig. 2, "Write or Die" is a web application with options for positive or negative reinforcement for writing. For example, a user can set a goal as specific word count and time allowed for writing. The writer can then experience positive (e.g., calming music such as ocean sound or selected images) or negative condition (e.g., unpleasant sound or writing box changing color to red) if the writing task is stopped over a specific period of time. The positive feature of this web application is its simplicity that does not require a long learning process, particularly including its similarity with other writing software, such as Notepad or MS Word. The application can also work in offline mode, and provides other settings, such as background and text color, for customization.

Fig. 2. "Write or Die" Interface [46]

B. Learning Context and Implementation Details

The active-learning method is implemented during the spring term of 2016 in the graduate course "Seminar in Transportation Engineering-CIVE 781", within the Civil, Construction, and Environmental Engineering department at San Diego State University. The course focuses on providing

foundational overview of several TE topics, including accompanying analytical methods. Moreover, the course focuses on teaching students essential software skills, such as Zotero, Matlab and VISSIM, as well as engaging students in a literature review writing and presentation exercise. Thus, as a mandatory course in graduate level, students gain fundamental overview preparing them for further graduate studies. As often the case with graduate courses, class size was small, including nine students. All students had a civil engineering undergraduate education and were at MSc level. Since course is following a seminar format, students are expected to routinely participate in class sessions. Writing-based in-class activity (WIA) using “Write or Die” was implemented in three formats:

1. A topic that is going to be discussed in the same session, allowing students to think about the topic from the beginning, and prepare for learning. Hereafter, this activity is referred to as “Start of class” WIA.

2. A topic just discussed in the class, which allows students and the instructor to evaluate the quality of the learning experience and how well students understood the concepts. Hereafter, this activity is referred to as “End of class” WIA.

3. A potential topic for the following session, which allows the instructor to understand students thinking as well as to tailor the material for a more efficient session. Hereafter, this activity is referred to as “Potential topics” WIA.

In total, eight practices were performed throughout the semester. Below is the list of questions used for the WIA, with the expected word count and time for the activity provided in parentheses. In addition, the list of course topics and schedule of in-class activities is presented in the following Table 1.

- WIA1: What is transportation engineering about? (100 words, 4 min) - “Start of class” and “End of class”
- WIA2: Describe the travel demand forecasting (TDF) process. (150 words, 5 min) - “End of class”
- WIA3: How different road users and vehicles characteristics impact a traffic system? Provide examples. (150 words, 5 min) - “End of class”
- WIA4: What do you know about traffic control devices? Purpose? Categories? Standards? (100 words, 5 min) - “Start of class” and “End of class”
- WIA5: Summarize what you have learned today about traffic data collection. (100 words, 5 min) - “End of class”
- WIA6: What do you know about traffic safety evaluation, analysis, and improvement. (100 words, 5 min) - “Start of class” and “End of class”
- WIA7: Based on what you have learned today, write a short paragraph on traffic congestion sources and mitigation strategies. (100 words, 5 min) - “Start of class” and “End of class”
- WIA8: What are some topics or tools that you would like to learn in this class? (100 words, 5 min) - “Potential topics” styled.

TABLE I. COURSE TOPICS AND SCHEDULE OF IN-CLASS ACTIVITIES

Date	Topic	Software	WIA
26-Jan	Course Overview, Introduction to Transportation Engineering		1
2-Feb	Travel Demand Forecasting	Zotero	
9-Feb	Four-Step Transportation Model		2
16-Feb	Road User, Vehicle, and Roadways Geometric Characteristics	Matlab/Excel	3, 8
23-Feb	Introduction to Traffic Control Devices		4
1-Mar	Statistical Applications in Traffic Engineering		
8-Mar	Traffic Data Collection and Reduction Methodologies		5
15-Mar	Volume Studies and Characteristics	Vissim	
22-Mar	Speed, Travel Time, and Delay Studies		
5-Apr	Highway Traffic Safety: Studies, Statistics, and Programs		6
12-Apr	MIDTERM		
19-Apr	Intelligent Transportation Systems		7
26-Apr	Extra (TBD)		
3-May	Presentations		
10-May	Final Exam (19:00-21:00), Paper due		

IV. EVALUATION METHODOLOGY

The evaluation plan of this pedagogical approach consists of two evaluation approaches, namely student survey and writing content evaluation.

A. Student Survey

A survey questionnaire was selected as the common method used in TE education [14], providing a method for capturing data that cannot be observed directly [47]. Survey questionnaire was designed to mainly identify students’ perception and acceptance as well as effectiveness of the pedagogical approach in students’ learning. The anonymous questionnaire consists of three parts. First part includes two true/false questions providing information on previous use of such writing tools. The second part focuses on questions asking students about the impact of the WIA, how it has helped them to summarize their thoughts, make connections between thinking and writing, and direct their focus on the topic. Questions have been asked from several standpoints, aiming at assuring validity. At the end of the questionnaire, an open answer question is used for providing comments, experiences, and suggestions. The survey questionnaire was prepared through Blackboard survey tool, and was administered twice, in the middle of the semester and at the end of the semester. Following is the list of survey questions, in their order. Questions one and two are true/false, questions three to fifteen are five-level scale from strongly agree to strongly disagree, question sixteen is five-level scale from greatly increased to greatly decreased, while question number seventeen is an open-ended question.

1. This is the first class in which I have used Write or Die.
2. I have used traditional writing practices in other classes.
3. Write or Die activity helps me to remember important course content.
4. Write or Die activity makes me more likely to attend class.
5. Write or Die activity helps me to pay more attention in the class.
6. Write or Die activity contributes to my learning.
7. Write or Die activity motivates me.

8. In the future, I would select a course section which uses Write or Die over another section of the same course which uses traditional writing practices.
9. I would like more professors to use Write or Die in their courses.
10. My professor seems comfortable with the Write or Die system.
11. I understand why my professor is using Write or Die in this course.
12. My professor asks Write or Die questions which are important to my learning.
13. Working with the Write or Die application allowed me to learn about my own writing strengths and weaknesses.
14. Time and word count goals set for Write or Die practices are suitable.
15. Write or Die is a user-friendly application.
16. The amount of time that we use Write or Die in class should be.
17. If you have any general comments or concerns about the Write or Die system, please add them here.

B. Writing Content Evaluation

The second approach for evaluation aimed at assessing the content of students writing during WIA. An assessment rubric with four levels was developed (Table 2). One aspect of the assessment is the content relatedness itself, as associational relation between the lecture material and the concepts provided by the student. The second aspect of the assessment is connectedness, as the level of clarity in the logical flow between concepts identified by the student. Both relatedness and connectedness are included in a single measure, since there is a strong correlation between them, and as they are good indicators of learning process during the class session. Moreover, the simplicity of this grading rubric allows for transparency and consistency of the assessment process.

TABLE II. ASSESSMENT RUBRIC

	Excellent = 4	Good = 3	Fair = 2	Poor = 1
Relatedness & Connectedness	All or significant majority of class topics are included in a comprehensive format, and they are clearly related.	Most class topics are included but are not well related to each other.	Few topics are included and the description of their connections is vague and/or confusing.	Very little topics included without any connection established.

V. RESULTS

A. Student Survey Results

For both the middle of the semester and the end of the semester surveys, all the students responded to the questionnaire. All students answered "True" for the first question indicating that none of them have used Write or Die before. For the second question, 78% of students used

traditional writing practices in other classes, and the rest (22%) indicated that they have not used traditional writing practices in other classes. The results of the surveys for questions 3 to 16 are shown in Fig. 3 and Fig. 4 in the form of bar charts, and are discussed below.

For question three, asking students if WIA helps them remember important course content, the majority of the students were indifferent about influence on remembering important course content up to the middle of the semester. However, most of the students changed their opinion to being mostly agreed toward the end of the semester. For question four, asking students about the incentive for attending class sessions, students were mostly positive about the WIA effect on class attendance. Answers to question five, focusing on students paying more attention in class, the majority of the students agreed that WIA helps them to pay more attention in the class. This conclusion was slightly improved toward the end of the semester. For question six, asking if WIA contributes to learning, students mostly agreed, especially getting closer to the end of semester. When asked about motivation effect in question seven, the students' opinions ranged from "strongly disagree" to "strongly agree" in the middle of the semester. However, as approaching the end of the semester, students were mostly agreeing or being indifferent regarding the motivation effect. For question eight, asking them if they would select a course which includes WIA over another section that uses traditional writing practices, none of the students answered "agreed" or "strongly agreed" during the mid-term evaluation. However, at the end of the semester, the distribution shifted towards larger percentage of indifference and some students agreeing to select a course including WIA.

Fig. 3. Survey results for questions 3 to 8

In response to question nine, asking students if they would agree that more professors should use WIA in their courses, the majority of the students were indifferent, at both survey times. For question ten, asking students if they agree that the professor seems comfortable with the use of Write or Die system, most of the students agreed with the statement. When asked about understanding why the professors is using WIA, the majority of students agreed, with this understanding improving toward the end of the semester. Question number twelve asked students if WIA asks questions important for

learning, and majority of students agreed, with the positive reaction to the statement improving towards the end of the semester. For question thirteen, which asked about if WIA application allowed students to learn about own writing strengths and weaknesses, mid-term results show that almost half of the students were indifferent toward this statement and the other half were equally agreeing and disagreeing. However, at the end of the semester, it seems the students were leaning more toward agreeing with the statement that Write or Die allowed them to learn about their writing strengths and weaknesses.

When asked about if time and word count goals set in WIA were suitable in question fourteen, the students generally agreed with the statement. Question fifteen asked students if they consider Write or Die to be a user-friendly application only at the end of the semester. Answers show that the majority of the students agreed that Write or Die is a user-friendly application. The final question sixteen asked about the amount of time that should be dedicated to WIA. In response, the majority of the students (100% at the end of the semester) think that the amount of time used for WIA should be kept the same. In the open-ended question, there were some positive and negative comments on the implementation of Write or Die. For example, students' comments included "I think write or die is a good way to reinforce material at the end of a class." and "Write or Die has helped me focus on some lecture topics." On the contrary, examples of a negative comments are "I guess writing practices is useful, but I don't like the Write or Die." and "I like the concept but I prefer to use Microsoft Word over the online application."

Fig. 4. Survey results for questions 9 to 16

B. Writing Content Evaluation Results

The result of the evaluation is provided in Fig. 5. On the figure, each column represents one student (nine students in

total), and each row shows a Write or Die WIA color-coded based on start or end of the class practice (blue for the start and green for the end). The bar charts are scaled from one to four, with four being the highest. The empty cells indicate the missing data (e.g., student being absent, etc.). WIA 2, WIA3, and WIA5 are WIA just conducted at the end of the class. The bar charts of these practices show that students had a better learning in the class sessions associated to WIA3 and WIA5 compared to WIA2. This result allows the instructor to go back to the material and seek the reason for the WIA2 session being less efficient compared to the other two, and revise the lecture method and/or material for a better outcome in the future. The results of WIA1, WIA4, WIA6, and WIA7 provide a comparative ground to evaluate how much students have learned in the class. The difference between the bar charts of the start and end of the class practices is a measure of student learning. As it can be seen in the figure, in majority of the cases the end of the class bar is higher than the start of the class bar. Another observation from the figure is that students had a better understanding of the WIA4 subject even at the beginning of the class since blue bar charts are high overall. This type of observation could also help with future design of the course for including some new material. Using this figure, individual students could also be tracked to assess their learning challenges. For example, student number 3 had a better record of learning at the end of the class compared to student number 6.

Fig. 5. Writing content evaluation results

VI. CONCLUDING IMPLICATIONS FOR ENGINEERING EDUCATION

This research focuses on the implementation evaluation for writing-based in-class activity, situated in the context of developing a learner-centered engineering education. In general, the research has been initiated with an objective to continue with the legacy in TE education development, by providing a starting point for implementing existing and new active learning tools, and stimulating ideas for new methods. In particular, the research has been focused on testing meaningful implementation of the writing activity. The meaningful implementation is even more important in the abundance of teaching technologies, whose implementation does not always have to be positive. However, the focus on writing was not for the sake of writing skills, but rather for in-class engagement and enhancing long-term learning. Moreover, the development

is contextualized within the focus on graduate seminar course with a small enrolment.

The in-class activity using Write or Die application proved to be an instrumental tool to evaluate students learning in the class, and to help them focus on the class subject. The feedback received through the students' survey shows that the activity might have positive effect on motivation and metacognition. Moreover, in-class activities assist the instructor with evaluating course material that should be included/excluded, or explained in a different way or with greater focus. Following are the reflections and lessons learned with implications for TE education.

- WIA implementation encourages students to focus on reflective practice of metacognition, by providing a deep-learning opportunity that connects thinking and doing. Furthermore, WIA encourages students to think about their thoughts, knowledge, and skills before and after the writing activity. These opportunities for metacognitive reflection can have a significant impact on developing lifelong learning skillset and attitude.

- WIA implementation provides students with a constructive sense of engagement from the teacher, aiding in their motivation for learning. In-class student engagement is an opportunity to connect active learning and motivation, which can work in synergy, in a two-way feedback loop setting.

- WIA implementation can enhance students' sense of responsibility for their learning process, by encouraging them to actively seek meaning from assessment, and pacing their activities to achieve deep learning.

- WIA implementation with short time limits (e.g., around five minutes) is acceptable for allowing the activity engagement to happen. Moreover, this time limitation encourages students to understand the need for performing under time constraints, which is often a feature of engineering practice.

- WIA implementation should be robust to account for a range of students' backgrounds. For example, writing activity can be contrasted with using a particular software or asking students to draw. On the contrary, writing is a generic activity, and in a direct connection to thinking processes.

- WIA implementation provides opportunity for the instructor to provide timely feedback, thus making it more useful for the student that can consequently use the feedback during the course. Moreover, WIA implementation provides an opportunity for the instructor to provide specific feedback, helping students to understand important misconceptions or areas for further improvement.

- WIA implementation has to account for the psychology of giving and receiving feedback, having in mind communication 'with' not just communication 'to' regarding students' future development. Here, one has to highlight the importance of student's reception of feedback. This relates to questions of identity as well as belief and self-esteem in personal knowledge. For example, if student has small belief in her capabilities, more explicit, proximal, and frequent feedback can provide repeated affirmations of developing capabilities.

- WIA has the potential to increase teacher's awareness of what are they actually achieving, which can contribute to their own development as a reflective practitioner. From this aspect, while the validity of assessment has to reach acceptable level, WIA reliability is less important because the fundamental purpose of the activity relates to development, rather than solely to measurement. In addition, a reflective practitioner should avoid seeking a "to do" list for implementation, and expect the best out of the first implementation.

- In addition to providing feedback to student and teacher, WIA has a dialogic role, since it can provide an opportunity for student and teacher to discuss the assessment and learning process in a timely and meaningful collaborative act. In particular, WIA implementation is applicable for increasing transparency of the communication process.

- WIA implementation has to acknowledge the effect of adaptation process, as students have to learn the assessment practice, and realize its benefits. The adaptation process has to account its inevitable connection to the learning process as well. For this, it is important to understand that WIA implementation relates to both reflective observation and abstract conceptualization phases of the learning cycle.

- Small enrolment in the graduate course has enabled efficient assessment of writing activities, that would otherwise be very time-laborious in large, undergraduate, courses. In addition to time, WIA effectiveness further relates other aspects of generalized implementation cost.

In the long term, this and similar implementations have the potential for encouraging a shift towards a continuous assessment of students and one-on-one assistance, while complementing a variety of ways for expressing the knowledge and assessing the causes of learning difficulties. In general, research tells us that our current "seating-time based" measures of educational attainment are not working anymore, and we need to modify the higher education system by organizing it around competence, flexibility and individual approach to students. Learning processes need to relate to beliefs, identification, independence, usefulness to goals, and choice – since they all relate to interest, motivation, effort and educational achievement. A step towards this is increase in students' self-directed learning, by partially giving up power by teachers and allowing students to take control and responsibility for their own learning. Something of this scale was impossible to accomplish 20 years ago, since the necessary technology was not ubiquitous. However, we now have the technological basis that can be used for fostering learning and assessment, as most of the software and hardware is readily available. We have broadband Internet, improved processing and graphical power, wikis, blogs, digital content, mobile and real-time access to information, social networking tools, etc. However, it is not just that obvious technology part. Just as blackboard and chalk were a revolution at some point in time as a tool to present larger amounts of information to many people, they required additional development in standards, methods and practices. However, further implementation is where our professional judgment needs to determine what, when, and how, thus adopting the attitude of continuous problem-solving. To this end, faculty should be supported to

increase the utilization of online resources that could improve cost-effectiveness as well as to collaborate more with education researches for improving their techniques. Finally, awarding faculty (with more time, resources, different tenure criteria, etc.) that invest additional efforts and develop new teaching techniques should become a state-of-practice.

A. Writing Content Evaluation Results

Following the premise of providing a starting point for implementing active learning tools and stimulating ideas for new methods, one has to recognize that the use of the Write or Die application is not completely in line with its original purpose. As Write or Die application is intended for improving writing skills themselves, further evaluation implementation could focus on out-of-class writing activities. For example, in out-of-class setting, students will be able to deploy all Write or Die features for positive or negative reinforcement. Thus, combined with other assessment techniques, such as learning diary, the tool could be used to improve writing skills, which are essential for graduate TE students' professional development.

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