Volume 5 Number 1
Summer 2017

The CTE Journal

An International Peer Reviewed Career and Technical Education Online Journal

Sponsored by Indiana ACTE

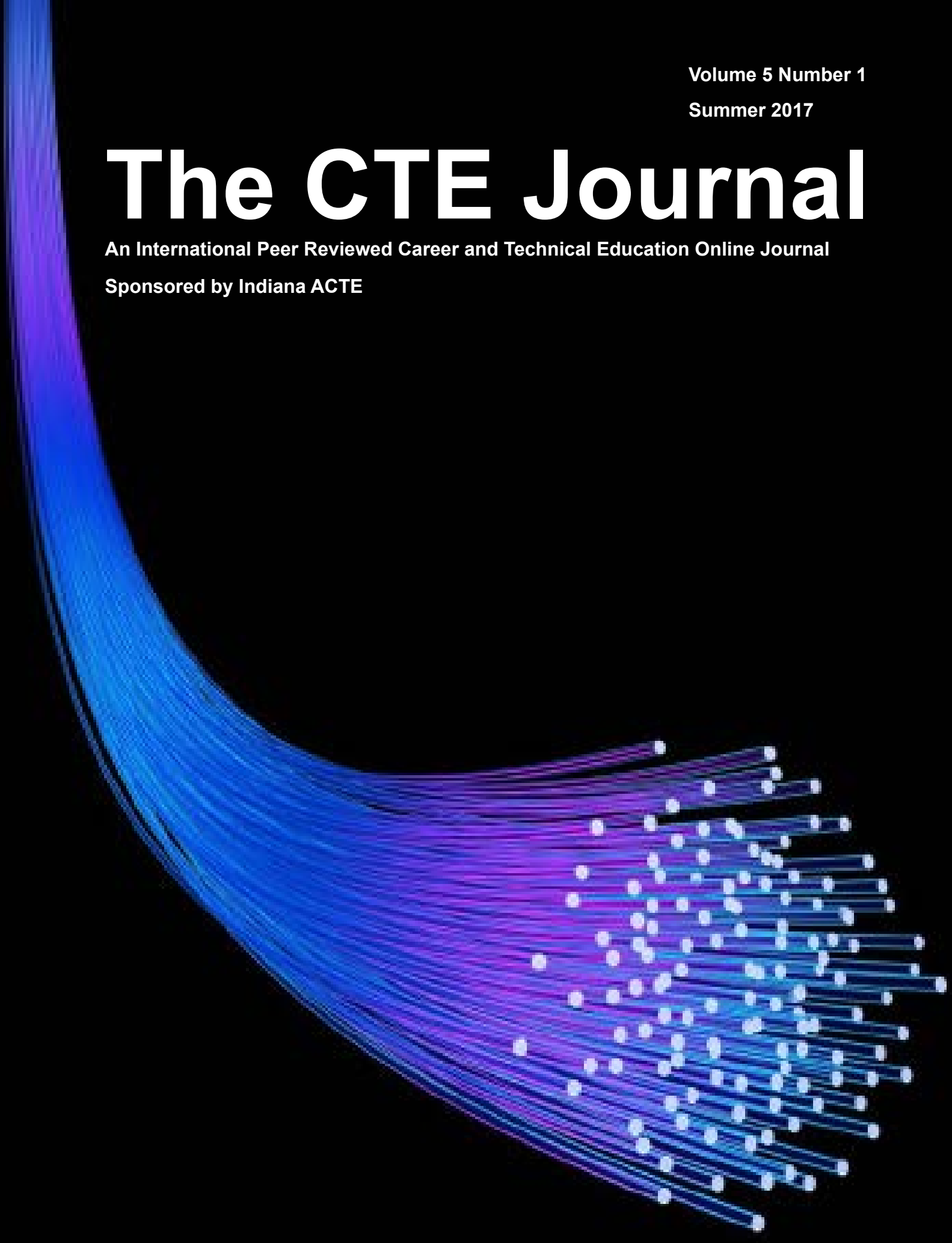


Table of Contents

Volume 5, Number 1, Summer 2017

Construction Cost Estimator - Career Exploration

Sherif Attallah, James W. Jones, and Ashley Hilliker

Ball State University

soattallah@bsu.edu; jwjones@bsu.edu; amhilliker@bsu.edu

Abstract
The construction industry is one of the most diversified fields due to the large number of products, systems, methods and processes that are involved to complete different types of projects. Therefore, a very wide range of expertise and skills are required for any successful business or project in this industry. People, specifically students, who have interest in joining this important industry need to understand the qualifications for these different expertise areas so that they can decide which one is of more interest to them. The purpose of this paper is to provide insight on the qualifications and skills required for a cost estimator in a construction company, as one of the critical site jobs, and to explore the relevant career potential. The paper also includes valuable information through the use of interviews with two of the professionals in this area of expertise.

Introduction

Within construction, there are various positions and specialties that aid in the formation and completion of a project. Of specific interest is that of a cost estimator. With every prospective project in construction, it is imperative to have professionals that are able to effectively estimate the costs and explain the reasons for such costs (US News). Cost estimators are responsible for collecting and analyzing data in order to estimate the time, costs, and materials needed to construct a building or provide a service. As they estimate expected production rates of various activities within construction, they often refer to historical data in order to understand how previous activities were achieved (Kiziltas & Akinci, 2009). Cost estimators also typically specialize in a particular area, but can be utilized in almost any field that offers goods and services. Therefore, it is imperative for those pursuing a career in cost estimation to understand the necessary skills and competencies to fulfill such an important role, specifically within the construction field.

While the current outlook for cost estimator positions appears to be on the rise, this may be a result of the lack of qualified individuals seeking this career. Furthermore, valuable experience and knowledge is being lost due to current cost estimators retiring (Alroomi, Jeong, & Oberlender, 2012). Therefore, it is important for emerging cost estimators to understand the various skills required to perform duties efficiently, such as analyzing what is missing, asking the right questions, being able to read and interpret drawings, and the ability to envision the larger picture of the project (Alroomi et al., 2012). This will allow the estimator to provide accurate cost estimations and fulfill other various duties. Cost estimators provide a valuable service to contractors, engineers, and companies by providing a detailed estimate of the overall cost of a project. Within construction, cost

estimators' duties are specific to the field, and as other careers, come with challenges to the job. For example, estimator bias, design complexity, and project size are just a few of the factors that can influence the work of a cost estimator (Akinci & Fisher, 2008). Furthermore, challenges often involve the drawings and specifications, which may not be clear or sometimes include contradicting information. In this case, the estimators must communicate with the architect/engineer or the client for clarifications. The availability of the materials needed for a project may also pose a challenge, especially if they are custom made or unavailable in the market. Project specifications are also sometimes written in a very stringent manner that leads to inflated prices of materials while the design intent and the client's actual objectives do not require this. This can lead to overpriced proposals that reduce the bidding success rate.
Regardless of the challenges of cost estimation work, the outlook for this career is promising, as it offers a wide-range of responsibilities, opportunities, and challenges that will allow for growth and experience.

Responsibilities of Cost Estimators
The cost estimator position is a very critical one in any construction company. In many cases, contractors have to submit a quote or a financial proposal to the clients before they reach an agreement or a contract to start a project. Cost estimators are the personnel responsible for reviewing the scope of work that the client is looking for. Following this, a cost estimator will typically make a quantity take off where he/she measures the exact quantities of materials, systems, or equipment that will be used in the project. This step is based on the design drawings issued by the client or the architect/engineer who did the design work for the client. After this, the estimators define the characteristics or properties (technical specifications) of these counted materials/equipment using the drawings or another set of documents called project's specifications, which should also be issued by the architect/engineer. Accordingly, the estimators would seek prices for each of these project components (materials or equipment).

Thus, the costing phase can take two forms. The first one is when the contractor intends to execute a certain scope of work with the company's own crews. This is called self-performed scope. The estimators would estimate the number of number and calibers of the crews that will perform the job and the construction equipment needed. A cost is then assigned for each man-hour and operation time for the used equipment to formulate a price for labor and equipment, which is then added to the cost of materials (directly supplied to the contractor) in order to formulate a total cost of these self-performed scopes. The other option is to delegate some of the scope to sub-contractors. In this case, the estimators would send drawings and specifications for the selected work packages and ask other individuals rather than just a sub-contractor to price these packages. One last step to formulate a price for a project is to add all packages together and then multiply by a percentage for overhead and profit that is agreed upon with the company management. These percentages need to be carefully considered, as they affect the competitiveness of the companies' proposals.

Becoming a Cost Estimator
As a rule of thumb, a Bachelor's degree is usually preferred to become a cost estimator. However, candidates with extensive work experience may be considered. A strong background in mathematics is essential for this career, as well as education in construction management or engineering if candidates would like to pursue a job in the construction field (Bureau of Labor Statistics, 2015).

Pay and Benefits for a Cost Estimator
According to Truity.com, the median salary for a cost estimator was $58,860 in 2012. However, the top 10 percent of those working in cost estimation earned over $96,000 as of 2012. This salary difference provides further evidence for the growth that is possible within this position.

Job Outlook for Cost Estimation
According to the Bureau of Labor Statistics, the opportunities to become a cost estimator appear to be on the rise. Specifically, it is projected that employment in this career is expected to grow 9 percent from 2014 to 2024 (Bureau of Labor Statistics, 2015)

Interviews with Korey Collier and Garrett Homan, Current Cost Estimators
In the following section, you can read the questions that Korey and Garrett were asked about their career, as well as their responses:

1. How long have you been involved in cost estimating?

   Mr. Collier stated that he has been a cost estimator for almost 10 years, while Mr. Homan stated that he has been working in the profession for almost 2 years. Both of these estimators stated that they did internships prior to starting their careers.

2. Can you provide a snapshot of your daily tasks?

   The cost estimators described a similar process in regard to their daily tasks, including quantity take-offs, using software to calculate materials and estimates, and being in constant contact with contractors and vendors. Furthermore, each described that the work they do varies day to day depending on the project. Korey stated, *"My daily routine consists of many things. Each job is different. A typical estimate takes 5 to 7 days, depending on the size of the job. My daily tasks will depend on where I am in the estimate take off.*

   Similarly, Garrett notes that, *"Daily tasks are always changing for me, it just depends on the project and what stage of the project I am working on. Every project is different in size."* Furthermore, interpreting and analyzing the drawings from the project design is a crucial task that both estimators stated was of great importance in their jobs.

3. After working in the industry, what are the skills or competencies you would recommend that every CM student should focus on before graduation?

Korey and Garrett both stressed the importance of communication skills, in that it is vital for a project's success to be able to effectively communicate with those involved in the project. Korey also stressed the importance of being able to work effectively with others in teams of 2 or 3 and is "detail oriented." Similar to this point, Garrett stated the importance of organization, noting that "*If you aren't organized, you aren't efficient, and you will not be productive. Anyone can estimate, anyone can be a project engineer or manager; but if you aren't organized, it won't matter what your job is because you won't be able to get anything done."*

4. What are the challenges meeting a cost estimator?

The main challenges stated by Korey consisted of time constraints, catching small details that may not be present in the drawings, and unclear drawings. Therefore, assumptions about drawings or specs may have to be made due to time constraints and the lack of timely responses from architects. Garrett also discussed the challenge of meeting each customer's needs, given the variation of each project. Garrett stated that, "*sometimes estimating turns into "guestimating", which means that sub-contractor and supplier quotes can be extremely different when receiving multiple quotes for something on one specific item."*

5. What is the best thing you like about your job?

Korey and Garrett both discussed the excitement of getting to work on different projects. Even though the process of their work is similar, both estimators stated that no two projects are the same. Furthermore, Korey expressed the fact that he loves the people he works with, stating that they have a "great team." Garrett also stated that he sometimes gets to work with other co-workers, but also enjoys the challenge of working on projects independently.

6. How important are interpersonal skills in your area of work?

Korey and Garrett stressed that interpersonal skills are of critical importance. They often work in teams, and thus stated that you must communicate clearly so everyone is on the same page. Furthermore, Garrett stated that, *"listening, negotiation, problem-solving, decision-making, and assertiveness are a few examples of skills that every CM student should attain upon graduation"*. The estimators also stressed the importance that interpersonal skills play in forming good relationships with coworkers. Without communication, productivity can be effected.

7. Do you consider thorough review of drawings and specs to prepare a cost estimate a mentally exhausting activity?

   Both of the cost estimators interviewed discussed that reviewing drawings and specs can be exhausting and difficult to understand. However, Korey stated that while it was more difficult to digest all of the information his first few years on the job, it became less overwhelming with experience. However, Korey stated it is most exhausting when he has to work on multiple estimates at a time, as it is difficult to juggle, but sometimes necessary.

   Similarly, Garrett expressed that it can be very difficult to understand the specs from project to project. He stated that it is often difficult due to the varying set of specifications of each project from the architect/engineer. However, Garrett noted that "*all in all, every project has different characteristics, but the process of estimating is usually very similar."*

Conclusion

Cost estimating in the construction industry is a very essential task in both pre-construction and post-contract phases. Therefore, there is a continuous demand for cost estimators who have the skills to work on securing projects or manage budget and cost during execution of projects. This job requires high level of attention to details in addition to accurate soliciting and reporting of cost data along with the technical capabilities to deal with project documents including drawings, specifications and contacts. Cost estimators are always expected to address uniqueness of each project and at the same time align with the company's standards and procedures for estimating and bidding processes.

References

Akinci, B., & Fisher, M. (1998). Factors affecting contractors' risk of cost overburden. *Journal of Management in Engineering*, *14*(1), 67.

Alroomi, A., Jeong, D. S., & Oberlender, G. D. (2012). Analysis of Cost-Estimating Competencies Using Criticality Matrix and Factor Analysis. *Journal of Construction Engineering & Management*, *138*(11), 1270-1280.

Kiziltas, S., & Akinci, B. (2009). Contextual Information Requirements of Cost Estimators from Past Construction Projects. *Journal Of Construction Engineering & Management*, *135*(9), 841-852.

Retrieved from "Cost Estimator Career Profile", http://www.truity.com/career-profile/cost-estimator.

Retrieved from "Cost Estimator Overview. US. News:", http://money.usnews.com/careers/best-jobs/cost-estimator.

U.S. Bureau of Labor Statistics (2015). Occupational Outlook Handbook: Washington, DC.

Note: Interviews with Mr. Korey and Mr. Garret were done during December 2016.

Adult Learners and Project Lead the Way: A Comparison Study of Reading Levels

Jacquelyn Covault

Purdue University Northwest, Westville

jcovault@pnw.edu

John Buckwalter, Brandon Sorge, and Charles Feldhaus

Indiana University Purdue University Indianapolis

jkbuckwa@iupui.edu; bsorge@iupui.edu; cfeldhau@iupui.edu

Abstract

This pilot study explores the connection between six adult learners' reading levels and the grade equivalent text levels of four Project Lead the Way (PLTW) learning modules: Principles of Engineering (POE), Introduction to Engineering Design (IED), Computer Integrated Manufacturing (CIM) and Digital Electronics (DE), Introduction to Engineering Design (IED).

Specifically it examined the graded reading levels of the PLTW lessons the learners were reading. Additionally it examined whether or not these lessons could be read and comprehended by the learners, and if there was any discrepancy between learners' reading levels and PLTW text levels. It explored if any discrepancies might have helped or hindered their success in achieving industry certifications. This study also explored if the reading abilities of the adult learners allowed them to proceed beyond earning industry certifications.

Introduction

EmployIndy is the Workforce Investment Board (WIB) for Marian County, Indiana. In 2009, EmployIndy launched Business Solutions to implement sector-specific strategies tailored to the diverse demands of individual organizations at no cost. This demand-driven approach to talent development has resulted in more than $1.5 million saved by Indianapolis businesses and more than $12 million invested in training since 2010, leading to a better prepared workforce to continue to drive the growth of the local economy. As a result of these demand-driven strategies, since 2008, EmployIndy has partnered with more than 350 organizations and helped more than 22,000 people receive training or employment. As the administrator of several national and local initiatives and grants including healthcare, IT, STEM disciplines and community redevelopment, EmployIndy is Marion County's authority for defining the needs for a successful local workforce and driving the growth of a strong economy. This information can be found at https://www.employindy.org.

In 2014, EmployIndy approached the STEM Education and Innovation Research Institute (SEIRI) at Indiana University Purdue University Indianapolis (IUPUI) to discuss exploring specific opportunities for increasing educational attainment in the adult workforce in Central Indiana. SEIRI functions as an independent unit administered by the Office of the Vice Chancellor for Research in collaboration with the School of Science, School of Engineering and Technology, Informatics, and the IU School of Education. The institute serves as the STEM education innovation, research, evaluation, and consultation hub, bringing together expert educational researchers with scientists and discipline-based educational researchers in order to inform and reform pre-college, undergraduate, and graduate education across IUPUI's campus and beyond.

PLTW is a hands-on, activity based curriculum founded in the fundamental problem-solving and critical thinking skills necessary for any occupation in today's economy, taught in traditional career and technical education but at the same time integrating rigorous math and science principles. An expansion of PLTW will put academic classes, both "regular" and remedial, into career context for a broader cross-section of the current and future workforce. Perhaps more importantly than the core academics is the amount of collaborative group work typically found in a PLTW classroom. When students start from day one with a focus on their ultimate career outcome, having context makes all the difference. By expanding PLTW into the adult workforce education system, the creation of a STEM Career Pathways for adults utilizing the PLTW Engineering, Biomedical Science and Computer Science programs could be forged.

SEIRI was qualified to conduct this work as STEM workforce development and research are a part of its mission. SEIRI was engaged in longitudinal analysis of PLTW data from 2008 through the present to examine student choices in post-secondary majors, persistence, matriculation, graduation and numerous other variables. SERI provided evaluation and assessment services for K-12 and post-secondary STEM educational grants, including federal, state and local funded projects, statewide. Finally, SERI was engaged in similar work for the Indiana Education Roundtable to re-design the Workplace Specialist I teacher-training program that certifies adult educators who teach at area CTE Centers. Participating faculty are already certified to teach PLTW courses.

After discussion and review of the literature, EmployIndy and SEIRI agreed to provide a PLTW curriculum review, rewrites and recommendations that would address the following key items for PLTW adult learners:

1. Adults will move through the curriculum at their own pace earning industry recognized certifications along the way, possibly including a high school diploma, that will earn post-secondary credit toward degrees in pre-engineering, manufacturing technology, biotechnology and computer information.
2. Necessary math and science courses needed to succeed in these courses will be offered simultaneously with the program thus there will be no remedial courses that will serve as "prerequisites" to the career pathway programs.

3. Curriculum will move from standards-based to competency-based, utilizing pathway appropriate prior learning assessments.

Table 1 below details the project timeline and deliverables.

TABLE 1
PROJECT DELIVERABLE, TIMELINE AND PARTNER

Deliverable	April 1, 2014 – December 31, 2014			Proposed Partner Involvement
	1st QTR SPR	2nd QTR SUM	3rd QTR FALL	
Identify criteria for selecting 1-2 Indiana Adult Education centers and/or adult workforce education providers well positioned to implement competency based career and academic pathways based on Project Lead the Way curriculum and courses	X			SEIRI, EmployIndy, Project Lead the Way
Select 1-2 Indiana Adult Education centers and/or adult workforce education providers to implement competency based career and academic pathways based on Project Lead the Way curriculum and courses	X			SEIRI, EmployIndy, Project Lead the Way
Identify regional industry recognized certifications to be integrated into competency based career and academic pathways based on Project Lead the Way curriculum and courses in adult education settings	X	X		SEIRI, EmployIndy, Project Lead the Way, adult education providers
Identify, align and/or recommend increased opportunities for dual credit courses among adult education centers offering competency based career and academic pathways based on Project Lead the Way curriculum and courses	X	X		SEIRI, EmployIndy, Project Lead the Way, Ivy Tech Community College
Modify existing PLTW curriculum to enable self-paced academic and	X	X	X	SEIRI, EmployIndy, Project Lead the Way,

Deliverable	April 1, 2014 – December 31, 2014			Proposed Partner Involvement
	1st QTR SPR	2nd QTR SUM	3rd QTR FALL	
performance-based learning for adults				adult education providers
Identify potential for industry based certifications connected to the competency based career and academic pathways based on Project Lead the Way curriculum and courses	X	X	X	SEIRI, EmployIndy, Project Lead the Way, adult education providers
Assess bridging competency based career and academic pathways based on Project Lead the Way curriculum and courses to existing Institutes at Ivy Tech	X	X	X	SEIRI, EmployIndy, Project Lead the Way, Ivy Tech Community College
Develop recommendation for necessary courses and/or offerings to bridge competency based career and academic pathways based on Project Lead the Way curriculum and courses to existing Institutes		X	X	EmployIndy, Project Lead the Way, Ivy Tech Community College, SEIRI
Determine prior learning assessments for adults entering competency based career and academic pathways based on Project Lead the Way curriculum and courses and provide certification	X	X		EmployIndy, Project Lead the Way, Ivy Tech Community College, SEIRI
Develop opportunities to earn certifications through pathway selection based on prior learning.	X	X	X	EmployIndy, Project Lead the Way, Ivy Tech Community College, adult education providers, SEIRI

Identify language requirements for success in the competency based career and academic pathways based on PLTW curriculum and evaluated through existing assessments	X	X	X	EmployIndy, Project Lead the Way, Ivy Tech Community College, adult education providers, SEIRI
Identify effective language remediation for adult learners entering competency based career and academic pathways based on Project Lead the Way curriculum and courses	X	X	X	EmployIndy, Project Lead the Way, Ivy Tech Community College, adult education providers, SEIRI
Pilot initial curriculum for adult learners with Goodwill Education Initiatives and/or selected adult workforce education provider/s			X	SEIRI, EmployIndy, Project Lead the Way, adult education providers
Develop recommendations for increased impact on workforce education system			X	SEIRI, EmployIndy, Project Lead the Way, adult education providers

Research Purpose

The purpose of this pilot study is derived from two of the specific deliverables previously mentioned:

1. Identify language requirements for success in the competence based career and academic pathways based on PLTW curriculum and evaluated through existing assessments
2. Identify effective language remediation for adult learners entering competency based career and academic pathways based on PLTW curriculum and courses

These deliverables, in turn, engendered the following questions:

Research Questions

1. Were the PLTW lessons written at a grade-level at which participants were able to read them?
2. Were the participants able to comprehend the PLTW lessons and then able to act upon what was required of them after reading them?
3. Was the lack of reading skills or reading proficiency a barrier for these students to earn industry certifications, a GED, high school diplomas or post-secondary credits?

The Role of Literacy and Content Area Instruction

Being literate means being able to communicate via reading, writing, speaking, listening, viewing, demonstrating and being able to think critically. Reading *fictional* (*aesthetic)* text requires a similar, but also somewhat different skillset than reading *informational* (*expository or content area)* text. Readers will typically encounter difficulty when reading e*xpository* text because this type of text is usually much more lexically dense,

uses more academic or content area vocabulary, and frequently deals with more abstract concepts than *aesthetic* text. The literacy demands of different content-areas vary substantially (Grossman & Stoldolsky, 1995), and the research clearly supports the use of a variety of comprehension strategies to enhance learning in the content areas (Haller et al., 1988; NRP Report, 2000).

Due to the fact that PLTW is a learning curriculum which requires the reading of expository texts and content-area vocabulary, and also requires adult learners to utilize problem-solving and critical thinking skills in order to master the curriculum, it was determined that it was necessary to identify the readability, or grade-level equivalency of each of the PLTW lessons. Equally as important was assessing the reading ability of each adult participant. It was decided the New Dale- Chall, 1995 Readability Formula would be utilized for determining the grade-level equivalent of each PLTW lesson, and the Analytical Reading Inventory, (ARI) Woods & Moe, 2014, would ascertain the grade-level reading equivalency of each participant.

Dale-Chall and Fry Readability Formulas

Readability formulas use word difficulty (frequency, familiarity, and length), and sentence difficulty (complexity and length) as factors in the way words are measured. This study utilized two readability formulas, the Fry, 2006 and the Dale-Chall,1995, in order to ascertain the difficulty or grade-level appropriateness of the PLTW learning modules. Both of these reading formulas consist of two different measurements; however these measurements differ for each formula.

In order to analyze a text, the Dale-Chall formula involves selecting a small number of sample passages, and analysis is based on a *syntactic variable* (sentence length) and a *semantic variable* (number of hard words). The Dale-Chall formula can be used for texts from grade four through college level. The Fry differs in that it employs sentence length variable and also a number of syllables per 100 words variable. The Fry formula can be used for texts from grade one through college level.

Initially, the Fry Readability formula was used for this study, but it was eventually discarded in favor of the Dale-Chall formula. The rationale for this was that the Fry formula seemed to be scoring the PLTW texts at very low grade-levels and it was believed this was due to the fact that it was relying on the number of syllables per 100 words. Conversely, the Dale-Chall formula calculated the number of hard words, i.e., words in the text sample which do not appear on lists of 3000 easy or familiar words, and was therefore providing what was believed to be a more accurate score of grade-level equivalence due to the fact that content area words would be considered harder words and the texts being evaluated were expository and therefore more content-based in nature.

The Dale- Chall Readability Formula from Micro Power & Light, (Dale-Chall, 2011) a computer software program that can measure text levels was used to compute the readability score for each of the PLTW modules. This can be found by clicking on the

following link: www.readabilityformulas.com/new-dale-chall-readability-formula.php This formula uses a small number of sample passages of 150 or more words from each learning module was inserted into the program. The program then calculated the difficulty of the passage using the following formula:

$$\frac{0.1579\ (difficult\ words * 100)}{number\ of\ words} + 0.0416\ \frac{number\ of\ words}{number\ of\ sentences}$$

Difficult words are words that do not belong to a list of 3000 familiar words composed by Dale-Chall. The program then computes scores and a grade-level equivalency is given using the following table:

Table 2
Dale – Chall Scores And Grade Level Equivalencies

Adjusted Score	**Grade Level**
4.9 and Below	Grade 4 and Below
5.0-5.9	Grades 5-6
6.0-6.9	Grades 7-8
7.0-7.9	Grades 9-10
8.0-8.0	Grades 11-12
9.0-9.9	Grades 13-15 (College)
10 and Above	Grades 16 and Above (College Graduate)

Project Lead the Way Learning Modules Used

A total of four modules encompassing 357 lessons in the PLTW curriculum of Principles of Engineering (POE), Introduction to Engineering Design (IED), Computer Integrated Manufacturing (CIM) and Digital Electronics (DE) were tested for their grade level reading equivalents levels using the Dale-Chall formula. The following PLTW website https://www.pltw.org/our-programs describes what students encounter in each of these curricular areas:

- Principles of Engineering (POE)- Students explore a broad range of engineering topics, including mechanisms, the strength of structures and materials, and automation. Students develop skills in problem solving, research, and design while learning strategies for design process documentation, collaboration, and presentation.
- Introduction to Engineering Design (IED)- Students explore the engineering design process, applying math, science, and engineering standards to hands-on

projects. They work both individually and in teams to design solutions to a variety of problems using 3-D modeling software, and use an engineering notebook to document their work.

- Computer Integrated Manufacturing (CIM)-This course illuminates the opportunities related to understanding manufacturing. It teaches students about manufacturing processes, product design, robotics, and automation.
- Digital Electronics (DE)-This course provides a foundation for students who are interested in electrical engineering, electronics, or circuit design. Students study topics such as combinational and sequential logic and are exposed to circuit design tools used in industry, including logic gates, integrated circuits, and programmable logic devices.

The Dale-Chall Formula yielded a grade level for each of the 357 PLTW lessons. These grade levels ranged in readability from Grade 4 to College Level reading. Table 3 shows how many PLTW lessons scored at the different grade levels. This in turn has been converted to a percentage.

Table 3
Percentage Of Grade Level Scores Of PLTW Lessons
N=357

Grade Level	4	5-6	7-8	9-10	11-12	13-15	16+
How many PLTW Lessons Scored at this Grade Level	3	7	83	138	86	29	11
Percentage of Utility	1%	2%	23%	39%	24%	8%	3%

Table 3 shows that the greatest number of PLTW lessons (39%) were written at the 9th and 10th grade reading levels; the second highest number of lessons (24%) were written at the 11th and 12th grade reading levels; and the third highest number of lessons (23%) were written at the 7th and 8th grade reading level.

Table 4
No. Of PLTW Lessons And Their Reading Levels For POE, DE, CIM, IED

Module	Gr. 4	Gr. 5-6	Gr. 7-8	Gr. 9-10	Gr. 11-12	Gr. 13-15	Gr. 16+
POE	0 0%	2 2%	21 23%	33 36%	24 26%	7 8%	5 5%
DE	0 0%	1 2%	5 7%	22 35%	22 35%	12 19%	1 2%

CIM	0 0%	2 2%	33 35%	42 44%	18 19%	0 0%	0 0%
IED	3 3%	2 2%	25 23%	40 38%	20 19%	10 10%	5 5%

Table 4 shows each of the PLTW learning modules and the number of times a lesson scored at that particular grade-level equivalency.

This chart reveals that with the exception of the Design Engineering (DE) module, the largest percentage of grade level readability scores presented in the 7-8, 9-10 and 11-12 grade levels.

Analytical Reading Inventory

Research in reading and language asserts that reading involves interaction between the reader and the text. In fact, reading research supports the understanding that readers use their knowledge and experience during the comprehension process (Rosenblatt, 2005). Reading is a multi-faceted practice and reading formulas cannot take into account how the reader interacts with the text due to the fact that they only look at the printed nature of the text. Reading formulas are not able to respond to influences that communicate meaning, nor are they able to discriminate between written discourse and a meaningless jumble of words. Additionally these formulas are not able to account for factors that pertain directly to the reader such as interest, background knowledge or experience.

Therefore, it was decided that an independent reading inventory should be administered to all individuals who would be reading the PLTW lessons in order to determine each of their reading levels, and to discover if the PLTW lessons were at a level at which they could comprehend.

An independent reading inventory is a generic name for a diagnostic reading test consisting of a set of graded word lists and passages used to determine individuals' word recognition and comprehension skills. An independent reading inventory measures one's *independent, instructional* and *frustration* reading level. The *independent level* is the level at which there is adequate functioning in reading (99% accuracy in word recognition and 90% accuracy or better in comprehension) with no help from an instructor. The *instructional level* is the level at which the individual can read with at least 95% accuracy in word recognition and with 75% or better in comprehension with help from an instructor. An individual's *frustration level* would be where word recognition accuracy drops to 90% or lower and comprehension 50% or lower. In short this level is too difficult for an individual to understand even with instructor help (Wheelock, Campbell, Silvaroli, 2012).

The Analytical Reading Inventory, (ARI) Woods & Moe, 2014, an independent reading inventory which measures reading ability from fourth-grade through high school and

contains both narrative and expository text passages was used to determine each participant's reading level. Because the nature of the PLTW lessons is expository in nature, a reading inventory that could focus on expository text was considered to be preferable for determining each individual's reading ability.

This study utilized a case study approach. Creswell (2012) maintains that a case study can consist of one unit or several units of study. This case study consisted of six adults, 3 females and 3 males, whose reading abilities were tested using the ARI. Each was tested individually and asked to read a list of twenty vocabulary words beginning at a grade-five reading level. If an individual mispronounced or indicated they did not know five or more words at a particular grade level (75%), the vocabulary portion of the test was discontinued.

The next portion of the ARI test consisted of reading a graded passage followed by five comprehension questions about what was read. The graded passage started at the highest level at which the individual decoded all twenty words on the vocabulary lists. Therefore, if the individual scored 100% at the eighth-grade level on the vocabulary list, he or she would begin reading the eighth-grade graded passage. Individuals continued reading the graded passages until they reached their *frustration level*, the level at which their word recognition dropped to 90% or lower and their comprehension level on the questions was 50% or lower.

The individuals who were tested scored at grade levels ranging from grade 6 to grade 12.

Table 4 shows the grade level equivalency for each learner who was administered the Analytical Reading Inventory

Table 5
Grade Level Equivalency Of Individuals Who Were Administered The Analytical Reading Inventory
N=6

Female 1	Female 2	Female 3	Male 1	Male 2	Male 3
Grade 7	Grade 6	Grade 12	Grade 8	Grade 9	Grade 9

Discussion, Conclusions, and Recommendations for Future Research

1. Were the PLTW lessons written at a grade-level at which participants were able to read them?

An analysis of each of the PLTW reading lessons using the Dale-Chall formula showed that lessons ranged in reading levels from Grades 4 to 16+. An analysis of each participant's grade-level reading equivalency using the Analytical Reading Inventory, (ARI) showed their reading levels ranged from Grades 6 to 12. One participant scored at the 6^{th} grade level, one at the 7^{th}, one at 8^{th}, two at 9^{th}, and one at the 12^{th} grade level. Of the 357 lessons tested for their reading levels, the majority of lessons scored at the 9-10

grade level (39%), followed by the 11-12-grade level, which showed a percentage of 24%. Following these was the 7-8-grade level with a percentage of 23%.

It would appear that the participant who scored at a 12th grade reading level should have been able to read grades 4 through 12 or 89% of the PLTW lessons. Additionally, it would seem likely that those who scored at the 9-10 grade level should have been able to read lessons with a grade level equivalency from grade 10 through grade 4 or 65% of the PLTW lessons. Those who scored at the 7-8 grade level should have been able to read lessons that scored at the grade 8 to grade 4 range, or 26% of the lessons, and the participant who had a reading level of grade 6 would most likely have been able to read grade 6 through grade 4 lessons which accounted for only 3% of all PLTW lessons.

Due to the fact that a large number of the PLTW lessons were above most of the participants' reading abilities, the data show most of the participants would have had difficulty reading all of the PLTW lessons they needed to read to be successful.

2. Were the participants able to comprehend the PLTW lessons and then able to act upon what was required of them after reading them?
Due to the fact that all of the participants earned some industry certifications, it was determined that the reading levels of at least some of the PLTW lessons were written at levels at which participants were able to comprehend. Since reading and comprehending are two different things, the participants may have been able to read or *decode* the PLTW lessons, yet may have had difficulty comprehending how they needed to act upon them.

3. Was the lack of reading skills or reading proficiency a barrier for these students to earn industry certifications, a GED, high school diplomas or post-secondary credits?
The analysis of the reading levels of each participant showed that five of the six participants had grade 6 to grade 9 reading levels. Only one participant tested with a reading level at grade 12. In regard to their reading levels, the majority of the PLTW lessons ranged from grades 7-12 (86%).This suggests that in order for at least five of these participants to pursue future education by earning their GED, high school diploma or post-secondary credit, they would need to acquire the reading skills necessary to be able to read at a level commensurate with high school or post-secondary work.

Conclusion
Six adults participated in this pilot study. Data generated by determining the grade level readability of the PLTW lessons and the graded reading levels of five of the six adults who participated in this study showed a strong disconnect. The texts of the PLTW lessons were often written at a higher level than the participants scored in their ability to read them. This in turn, would affect their comprehension of the PLTW lessons and their ability to act upon what was required of them to be successful in their completion.

Future participants whose reading levels scored lower than the PLTW texts should participate in some type of developmental reading program in order to provide them with

better opportunities for reading success. While there is a relative dearth of research information on teaching adult populations to read and write, what is known is this: In order to be effective instructors of adult learners, programs where individuals skills are assessed, specific areas of weakness are planned for using differentiated instruction, and learning activities and materials are selected to meet adult learners from wherever they need to begin are necessary. Therefore, it is imperative that adults who are seeking to become better readers and writers, are engaged by instructors who are knowledgeable about teaching and possess the tools, skills and expertise to offer them the support they need (National Research Council, 2012).

References

Creswell, J. W. (2012) *Qualitative inquiry and research design: Choosing among five traditions*, 3rd edition, Thousand Oaks, CA: Sage.

Dale, E., Chall, J. (1995) Dale-Chall Scores and Grade Level Equivalencies. Retrieved April 10, 2017 from http://www.readabilityformulas.com/new-dale-chall-readability-formula.php

Dale, E., Chall, J. (2011) Readability Calculations-Readability Software. Micro Power & Light Retrieved May 18, 2017 from http://www.readabilityformulas.com/readability- calculations.php

Employ Indy Description. Retrieved June 30, 2017 from https://www.employindy.org

Grossman, P. L., & Stodolsky, S. S. (1995). Content as context: The role of school subjects in secondary school teaching. *Educational Researcher,* 24(8), 5-11.

Haller, E. P., Child, D. A., & Walberg, H. J. (1988). Can comprehension be taught? A quantitative synthesis of metacognitive studies. *Educational Researcher,* 17(9), 5-8.

Kress, J., Fry, E. (2006). *The reading teachers book of lists.* New York, New York: McGraw-Hill.

National Reading Panel. (2000). Teaching Children to Read: An Evidence-based Assessment of the Scientific Research Literature on Reading and Its Implications Human Development. Retrieved on January 7, 2017 from https://www.nichd.nih.gov/publications/pubs/nrp/pages/smallbook.aspx

National Research Council. (2012). Improving Adult Literacy Instruction: Options for Practice and Research. Committee on Learning Sciences: Foundations and Applications to Adolescent and Adult Literacy, A.M. Lesgold and M. Welch-Ross, Eds. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

Project Lead the Way Program Descriptions. Retrieved January 2, 2017 from https://www.pltw.org/our-programs

Readability Formulas. Retrieved January 7, 2017 from http://www.readabilityformulas.com/practical-purposes-of-using-readability-formulas.php

Rosenblatt, L. (2005). *Making meaning with texts: Selected essays*. Portsmouth, NH: Heinemann.

Wheelock, W., Campbell, C., Silvaroli, N. (2012). *Classroom reading inventory*, 12th ed.,

New York, New York: McGraw Hill.
Woods, M., Moe, A. (2014). *Analytical reading inventory: comprehensive standards-based assessment for all students including gifted and remedial.* New York, New York: Pearson.

Stakeholder Response to Virtual Learning Days in Public School Districts

David M. Hua, Christopher B. Davison, and Sagar Kaja

Ball State University

dhua@bsu.edu; cbdavison@bsu.edu; skaja@bsu.edu

Abstract
The purpose of this study is to investigate how virtual learning days have impacted students, parents, teachers, and school administrators. In areas where inclement weather results in school cancellations, virtual learning days provide an alternative that allows for continued instruction on those days. The Indiana Department of Education has established a policy that sets requirements for what can be considered an approved virtual learning day. This study surveyed superintendents throughout Indiana to determine the impact virtual learning days have had on their stakeholders. The survey found that the stakeholders would rather use virtual learning days than have to make up the lost instruction due to school cancellations. Survey respondents also noted beneficial changes to teacher pedagogy.

Introduction

The purpose of this study was to determine the impact and response that virtual learning days have had on various stakeholders. The stakeholders included students, parents, teachers, and school administrators. A survey was conducted of the school districts in Indiana. The findings in this study reflect those that have adopted a virtual learning day policy to address lost instructional time due to inclement weather.

The number of schools adopting virtual learning days, or "e-days" is increasing nationwide (McIntyre, 2016). Virtual learning or e-learning "can be defined as the use of computer and Internet technologies to deliver a broad array of solutions to enable learning and improve performance" (Ghirardini, 2011, p.3). McIntyre (2016) noted that school districts are increasingly choosing to continue the learning process even when inclement weather prevents students from being able to attend school. This study will present the observations made by superintendents of schools in Indiana that have approved virtual learning day policies by the Indiana Department of Education.

Efficacy of virtual learning (e-learning)

In regard to virtual learning, the first thing to consider is does it work. Davies & Graff (2005) found that virtual learning can improve student involvement, as well as improve the quality of discussions that occur. Davies and Graff also referenced the benefit of an online virtual community. Their evidence came from Blackboard usage, which revealed that in interactive areas, the students who received high or medium passing grades showed greater usage while lower scores came from students who failed the modules.

There are several additional factors to consider, one being the computer skills of the user. "Specifically, generalized computer self-efficacy, learner age, system reliability, social presence, and media synchronicity were all found to impact utility judgments and user satisfaction"(Bukhari, Khan, Shahzadi, & Khalid, 2014, p.185). By paying attention to the students' learning style detection method and students' choice, performance increased by 12% (Abdullah, Daffa, Bashmail, Alzahrani, & Sadik, 2015). Videos, diagrams, and pictures are all helpful tools for effective learning practices (Bukhari et al., 2014). A study in Indonesia found more direct results. For grade ten students, the study found direct correlation between computer skill and student achievement (Pardamean & Suparyanto, 2014). An interesting thing to note from Pardamean and Suparyanto is that female students reportedly enjoyed virtual learning more than male students.

The International Association for K-12 Online Learning (iNACOL) found that 25 states had virtual schools (iNACOL, 2013). These states and schools said that their reason for offering online classes were for content not otherwise covered at the school, and for recovering course credits. An earlier study refers to a lack of certified teachers, along with 2/3 of jobs requiring college or post-secondary education as additional reasons for providing online education (iNACOL, 2011).

Impact of school closures

When studying school closures, one would think to study the effects on the student's grades when they miss days. First let's look at a study in Massachusetts from 2003 to 2010 (Goodman, 2015) which looked at the students who stayed home when school was not cancelled for inclement weather. The study found that students who stayed home based on inclement weather showed lower achievement in math while full school closures showed no impact on test scores. Goodman cites the average student loses two weeks each year of school, so the investigation of individual student attendance is important. According to his calculations, each additional day lost when individual students stayed home results in lowering math scores up to 5 percent of a standard deviation. Goodman also found minority students, such as black, Hispanic, or lower SES children, had more missed days overall.

Another study (Marcotte & Hansen, 2010) found that less school days resulted in lower test scores. Marcotte and Hansen said that due to concerns over the use of resources and current policies, school years are currently 180 days. Other studies have found longer school years improve testing scores in various subjects (Hansen, 2008; Marcotte, 2007; Marcotte & Hemelt, 2007).

In a study of Maryland from 2002-2005, it was claimed that 35 additional schools would have met their adequate yearly progress had they not closed any days those years, (Marcotte & Hansen, 2010). Looking at the extended school year debate, a collection of 15 empirical studies from 1985 to 2009 (Patall, Cooper, & Allen, 2010) revealed that longer school years seems to support students, especially those at risk. However, the authors caution that the research designs do not make strong causal arguments and other

outcomes besides academic achievement should be studied. Time is just one factor, and long term effects as well as cost analysis benefits had not been examined (Patall et al., 2010).

State policies for virtual learning days

The Indiana Department of Education (IDOE) approved the Virtual Option during the 2013-14 school year. The Virtual Option allowed school districts to declare a virtual learning day on those days that would have been traditionally closed due to snow or other inclement weather. The use of virtual learning days avoided the need for requiring make-up days since they counted towards the state mandated 180 days of instruction. School districts could obtain permission to utilize virtual learning days by submitting a proposal to the IDOE that defined how they would address a series of pedagogical and logistical criteria that included (Morello, 2014; Swetlik, Graves, Hua, & Davison, 2015):

- The district must be able to prove all students and teachers have the ability to access the internet when they are away from the school building.
- All students and teachers must have experience using digital learning platforms.
- The district will inform students about their learning targets by 9 a.m.
- Parents and students will have the ability to reach teachers for help and questions throughout the "virtual" learning day.
- Student work will cover content that would have been addressed if school were in session.
- All students who have accommodations for instruction will be provided with or have access to those accommodations.
- For students with disabilities who do not use online platforms for learning or for those students whom online platforms are not appropriate, teachers will provide parents/caregivers with appropriate educational materials and learning activities for student use.
- For limited English proficient students, teachers will provide parents/caregivers with appropriate educational materials and learning activities for students use per the Individual Learning Plan.

An Ohio policy says that no more than 5 missed snow days are allowed annually before making them up later, meaning that some schools are using virtual learning days for additional snow days (McIntyre, 2016). Teachers may use blizzard bags to make up hours, for a total of three make-up days. Assignments are sent home or posted online for students to complete as a replacement of school time in the classroom (Phillips, 2014).

Methods

Survey instrument

This study utilized a survey administered through the Qualtrics online survey provider. The survey began with demographic questions about the school district about the size of the student population and whether the district was urban, suburban, or rural. The survey asked whether the district had a Virtual Learning Day policy. If so, in what year was the policy approved by the Indiana Department of Education. There is the possibility that despite having a Virtual Learning Day policy, the district may not have had the need to utilize it. Respondents were asked to indicate how many days per year Virtual Learning Days were used.

A series of open-ended questions asked how various stakeholders responded to the use of Virtual Learning Days. The stakeholders included students, parents, teachers, and school administrators. The respondents were then asked what benefits they had observed as a result of implementing Virtual Learning Days. They were also asked if there were any complications or challenges associated with using Virtual Learning Days.

Study sample

For this study, the subject pool was limited to the state of Indiana. The reason for this constraint was to ensure that respondents were not operating under varying guidelines. By restricting the subject pool to Indiana, all the respondents would be bound by the virtual learning day policy instituted by the Indiana Department of Education. E-mails were sent to the administrators of 320 school districts in Indiana. The e-mail requested the superintendent or an appropriate designee responsible the district's virtual learning days to respond to an online survey.

Results

The survey yielded a 36.5% response rate with 117 responses to the e-mail solicitation to participate in the virtual learning day survey (See Table 1). There were 26 school districts indicating that they have adopted a Virtual Learning Day policy, representing 22.2% of the total respondents to the survey. The remaining 91 respondents indicated that their school district has not adopted a Virtual Learning Day policy.

Table 1

Schools with Virtual Learning Day policies

	Frequency	Percent
No	91	77.8
Yes	26	22.2
Total	117	100.0

There were respondents from each community type (See Table 2). Urban communities only comprised 9% of the school districts responding to the survey. School districts from suburban communities represented 19% of the respondents. Among the responses, the clear majority at 72% came from school districts from rural communities.

Table 2

		Virtual Learning Day Policy		
		No	Yes	Total
Demographic Type	Urban	10	1	11
	Suburban	18	4	22
	Rural	63	21	84
Total		91	26	117

Within the urban school districts, only 1 of the 11 respondents indicated that their school district had adopted a virtual learning day policy to address lost instructional time due to inclement weather. A larger portion of the suburban school districts had virtual learning day policies in place. Among the 22 suburban school districts, 19% specified that they had enacted such policies. In addition to being the largest group of respondents, rural schools also had the highest proportion of school districts adopting virtual learning day policies at 24%.

Of interest was whether the school districts had utilized their virtual learning day policies instead of declaring a snow day. The survey asked the administrators to indicate how many virtual learning days had been issued for each year their policy had been in place. It can be seen in Table 3 that the single urban school with a policy had used virtual learning days instead of snow day on seven occasions. Suburban schools used virtual learning days on 29 occasions. One of the four suburban schools had not yet had an opportunity to declare a virtual learning day at the time of the survey. The total number of virtual learning days declared by rural schools was 116.

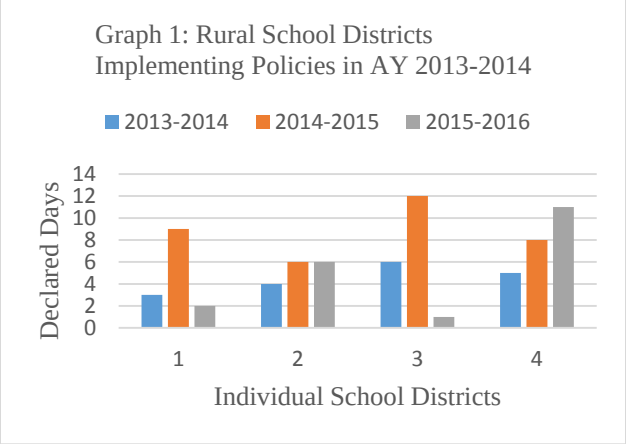
Table 3

	Total Virtual Learning Days
Urban	7
Suburban	29
Rural	116

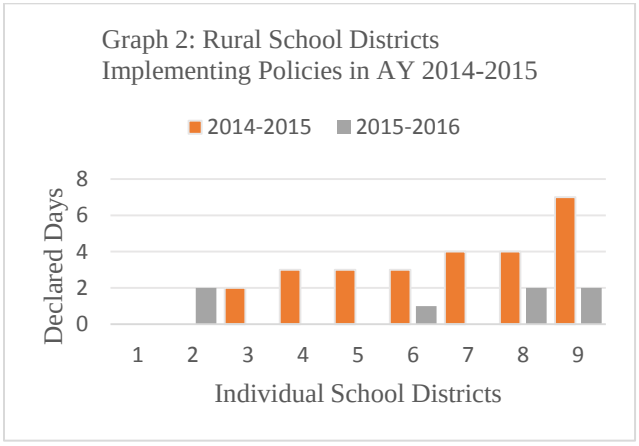
ISSN 2327-0160 (Online)
Volume 5. Number 1.

The series of graphs show the frequency of declared virtual learning days by rural school districts. Three of the rural school districts were not included in the graphs because they did not provide data about the number of virtual learning days they had declared. Graphs 1, 2, and 3 show the frequency data for school districts that introduced virtual learning days the 2013-2014, 2014-2015, and 2015-2016 academic years. The vertical axes indicate the number of declared virtual learning days. The individual school districts are organized across the horizontal axes. Each column represents the number of declared virtual learning days in a given academic year.

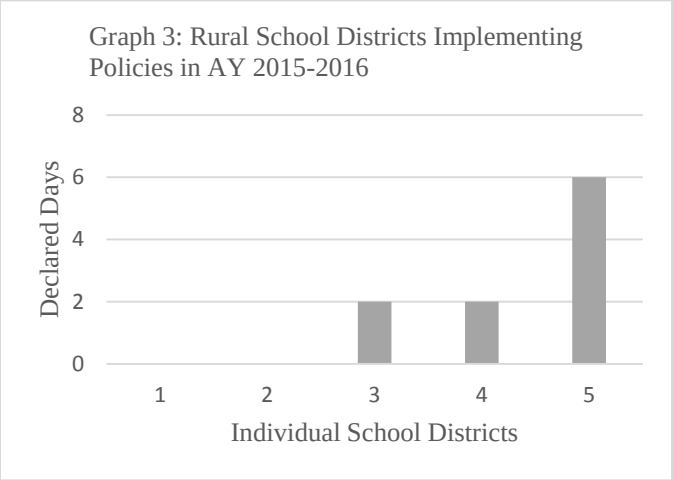
There were four school districts that implemented virtual learning day policies in the 2013-2014 academic year (see Graph 1). Over the three years covered in the survey, the total number of virtual days declared for each school district ranged from 14 – 24 days.



An additional nine school districts had approved virtual learning day policies starting in the 2014-2015 academic year (see Graph 2). The first school district had not yet had the opportunity to declare a virtual learning day at the time of the survey. The remaining school districts had from 2 – 9 virtual learning days during the two-year period.



The five schools that had implemented virtual learning day policies in the 2015-2016 academic year are show in Graph 3. Only three of the five school districts declared virtual learning days in their inaugural year.



It was anticipated that there would be variability in the frequency of declared virtual learning days among the school districts. The number of snow days any particular school district would declare in a given year would vary based upon geographic location and localized weather conditions. Schools in the northern region of Indiana are likely to be colder than those along the southern border of the state. Additionally, the schools close to Lake Michigan would be more prone to lake-effect snow. With these variations across school districts, further statistical analyses were not deemed to be appropriate.

Stakeholder response to virtual learning days

Students

The series of open-ended questions began by asking how students have responded to the use of virtual learning days instead of traditional snow days. Fourteen of the school districts stated that their students had responded well to the use of virtual learning days. One school district surveyed their students and found that "82% of students were in favor of eLearning Days."

One of the reasons commonly cited for supporting virtual learning days is the flexibility that it provides. It was noted that students liked the "flexibility that it provides them in their learning." Unlike a typical day in school, students are able to choose the order in which they will approach their day's assignments. Instead of the teacher, students have the autonomy to determine how much time they will spend on any given subject. While one student may be able to work through the math quickly and independently, another student would be able to take more time and seek out assistance from the teacher. It should be mentioned that the use of virtual learning days does not mean that students are

working without teacher instruction. The Indiana Department of Education requires that teachers be available to provide instruction on virtual learning days (Swetlik et al., 2015).

One of the school districts noted that "virtual lessons tend to be very engaging, and meets them where they live, in the digital world." This engagement was also based on the level of student participation. The learning management systems used by many school districts to implement their virtual learning environment typically log and timestamp student activity (Swetlik et al., 2015). Teachers are able to track what the students did and when. School districts were stating that they 94% - 95% student participation.

A noted contributor to engagement among the students was district wide 1:1 computer plans. With a 1:1 computer plan, each student has a dedicated piece of technology that is integrated into the pedagogy. The use of mobile technology such as laptop computers and tablets would provide an additional level of flexibility. Such devices could be used in both the classroom and at home. They can also provide students access to electronic copies of subject textbooks independent of location. School districts that effectively incorporate these technologies into their classrooms are likely to find that students will be engaged when a virtual learning day is declared.

Not surprisingly, students liked being able to do their work from home. The prospect of the potential fun and rest of a snow day is typically overshadowed by the realization that the day off is going to be made up at a later date. Most school districts in Indiana will already have built in make-up days to recover lost instructional time. If there are too many snow days or if they occur after the built in make-up days, it is common for the school year to be extended into what would have been summer vacation. It was noted that students appreciated that virtual learning days avoided the need for make-up days or extensions to the school year. At the same time, there were some students who indicated to the school districts that they would still rather have the day off.

Not all of the student responses to virtual learning days were positive. A couple of the school districts found that some students indicated that the work assigned on virtual learning days was "even more difficult than work regularly assigned in the classroom during a traditional school day." On a typical day in the classroom, the teacher will have planned out times for lecture and in-class activities. There can be a tendency for teachers uncomfortable with the use of online learning to respond by simply assigning more. This could be more reading or more assignments. Quantity, however, does not equal quality. It is incumbent upon the school district to provide its teachers with the professional development to effectively utilize virtual teaching tools and strategies if they are going to adopt a virtual learning day policy.

To ensure that students are prepared, some school districts indicated that they had implemented practice days. These practice days provide students with an opportunity to experience what will be expected once an actual virtual learning day is declared. Teachers and technology support would be available to make sure that the technology

works and that students are able to access the appropriate resources. It may take a few times for students to become comfortable with virtual learning days. One of the school districts indicated that students "are getting better with each one we implement." A couple of school districts that have not declared a virtual learning day yet stated that "we have had a couple of practice days 'in house' which have been well received by students."

Parents

Along with students, parents are a primary stakeholder impacted by virtual learning days. When inclement weather strikes, parents still must make arrangements for childcare whether a school districts declares a snow day or a virtual learning day. The issue becomes what their children are doing on those days. Three of the school districts indicated that parents were initially skeptical about the use of virtual learning days. One of the primary concerns related to helping their children with assignments. Some parents have expressed concerns with their ability to help their children. Other parents complained that after being at work all day, they have to come home and help their children with assignments. Because of this concern, that school district has instructed its teachers to not assign work that requires first time learning. "Assignments should reinforce content that has been presented previously be the teacher. We also encourage teachers to post instructional videos that reinforce the lesson." Another school district works with "local daycare facilities so they know and understand the expectations." The Indiana state guidelines state that instruction is to be provided on virtual learning days and that teachers are expected to be available 5 - 6 hours to assist (Swetlik et al., 2015).

Despite these initial concerns, almost all of the school districts found that the parents adjusted to the virtual learning days and are now very supportive. Surveys conducted by one school district discovered that "84% of parents were in favor of eLearning Days." A survey conducted by a second school district found that 89% of their parents responded positively to the use of virtual learning days. The parents provided a few reasons for their support. "They like the fact that days will not have to be made up at the end of the school year or during scheduled breaks. Snow make up days can have an impact of moving graduation dates and impeding on scheduled vacation time." Other parents said that "they love how students don't lose learning time because of weather." There will always be some that do not approve. One of the school districts shared that "a handful [of parents] are not happy and want to know when they will be paid for teaching their child." Here is a situation in which educating the parents on the available resources that the children should be using during the virtual learning day could be beneficial.

Teachers

As was noted by the parents, there is a misconception that students and parents are doing all of the work on virtual learning days while teachers get the day off. The Indiana Department of Education guidelines require that elementary school teachers be available to provide instruction for 5 hours on virtual learning days (Swetlik et al., 2015). The requirement increases to 6 hours for teachers of middle and high school students. The

protocol for how this should be accomplished, however, is not dictated. The state guidelines give school districts the autonomy to determine how virtual learning days will be applied. The stipulation is that students would receive an equivalent level of instruction. A possible misconception of virtual learning days is that students must learn all new materials and submit assignments all within the same day. This may be true if a teacher makes that decision. However, school districts and teachers are afforded the flexibility in the choice of instruction and due dates.

The flexibility afforded teachers was reflected in their responses to virtual learning days. Like the students and parents, most of the teachers responded favorably to the use of virtual learning days. The teachers also liked that not using traditional snow days avoided changes to the school calendar. One school district found that 96% of their teachers supported its use. Multiple school districts said that virtual learning days served as the catalyst for their teachers "to be more creative in the development of their VLD [virtual learning day] lesson plans." Another school district indicated that their teachers "have embraced online technology in their classroom as a regular part of their curriculum. This facilitates a natural progression of online learning away from the physical school environment."

It was noted by the school districts that while the response was positive, virtual learning days did create some complications for the teachers. "Some teachers find that the level of communication that is required is overwhelming, i.e. taking attendance, showing that all students are actively involved in the learning process through virtual means, logging student participation, and setting time parameters for the distribution and collection of materials." There were also teachers who chose to "go ahead and go to their classrooms to work during the day as it is easier for them." This also provided students an opportunity to come to the school and still receive face-to-face instruction if there were difficulties with the virtual materials.

School Administrators

The final set of stakeholders is the school administrators. All of the school district administrators were supportive of virtual learning days as a substitute for declaring traditional snow days. This was expected since the development and application for approval of a virtual learning day policy is based on an administrative decision. Their primary concern was ensuring the quality of instruction. To address this concern, school administrators "find opportunities for professional development and work hard to provide online platforms that support teachers in meeting standards of Indiana education."

The school administrators noted additional benefits from virtual learning days. "We feel that it reflects positively on our district and portrays us as cutting edge and innovative. This outside-of-the-box approach works well for our one-to-one district who has made the integration of technology a priority. We live this philosophy everyday, not just on Virtual Learning Days." This was supported by another school administrator who said, "I believe the preparation for the use of Virtual Learning Days has caused our teachers to

greatly improve their use of technology everyday in the classroom, which has in turn improved instruction over all." One opinion that was shared among school administrators was that virtual learning days are a better alternative than closing the school district for a snow day. However, they are not suggesting that virtual learning become a replacement for the face-to-face interactions between and among students and teachers in the classroom.

Benefits

Having addressed stakeholder responses, the survey asked school district administrators to identify the primary benefits they have observed from the use of virtual learning days. Ten of the school districts noted the positive impact virtual learning days have had on teachers. As a result of implementing virtual learning day policies, "teachers [have] expand[ed] their knowledge of software and platforms for virtual dialogue and submission of student work." Virtual learning days have required teachers to become literate with digital curriculum and learning management systems (e.g., Canvas, Moodle, Blackboard). "Teachers have been forced to be more creative in the type of instructional delivery to address content." These benefits were not limited to declared virtual learning days. School districts found that "more technology is being integrated into the classrooms on a regular basis."

Another commonly cited benefit of virtual learning days related to not having to alter the school calendar. All of the stakeholders appreciated not having to do built-in make-up days or extending the school year. Virtual learning days avoided disruptions to the continuity of learning that occurred with traditional snow days. Snow days have historically caused problems for teachers as they try to prepare students for the state mandated standardized testing that occurs each year. "Having several missed days of education in a row during critical learning times are no longer a detriment."

The benefit virtual learning days have had on students was frequently cited. A school districted noted that "students have gained a greater sense of independence with the use of instructional technology." It was also mentioned that students were "forced to learn self discipline to complete the tasks." This was imperative for virtual learning days to be considered a success. The observation that students appeared to be more engaged with the learning technologies may be a contributing factor to students staying on task.

One school district found that "community partners have embraced this type of learning and partnered to make these resources available throughout the community such as coffee shops, the library, etc." A potential roadblock to virtual learning days is the lack of Internet access in the student homes. School districts have partnered with community agencies and businesses to provide students with free Internet access. Students are welcomed to do their work at local community centers, libraries, and restaurants that provide Internet connectivity.

Complications or challenges

Thus far, this report has focused on the positive aspects of virtual learning days. That does not mean that they are without any complications or challenges. The most significant problem identified by school districts is Internet access in student homes. The most commonly stated reason for the lack of Internet access was the lack of availability. Earlier in this report it was presented that the majority of the responding school districts served rural populations. Families living far into the countryside may have limited or no access to the Internet. Some of the families said that their only way to access the Internet from home was through their cell phones.

This is a serious issue that could threaten the viability of virtual learning days. Many of the school districts shared their strategies for addressing this problem. One of the school districts uses what they call e-backpacks. Students are given the opportunity to download or receive all the materials they will need while at school on the day prior to an anticipated virtual learning day. With the materials in hand, students are able to complete their assignments even if they do not have Internet access at home.

Another problem occurs in districts that do not have a district wide 1:1 plan using mobile technologies. One of the school districts only had iPads available for students in grades 6 - 12. They did not indicate how they accommodate students in grades K – 5. Families in districts that do not provide mobile technologies may have to use their own computing devices or computers available through community partners.

Whether the problem is Internet access at home or lack of computing devices, many of the school districts have flexible due dates on virtual learning day assignments. For example, one school district stated that they "allow 5 days to complete work and allow building computer labs to be open before or after school." The community partners identified earlier provide alternative locations for accessing the Internet. Some of the teachers and administrators open the schools on the virtual learning day or subsequent Saturday for students who do not have Internet access at home.

Weather forecasting presents another logistical problem. When threats of inclement weather are reported in advance, teachers have the time assemble the resources students will need on the impending virtual learning day. When the inclement weather is not forecast or is worse than predicted, teachers have until 9:00 AM on the virtual learning day to communicate the day's assignments to students (Swetlik et al., 2015). If unable to meet this requirement, the school district may still have to declare a snow day that would have to be made up at a later date.

Conclusions

The Indiana Department of Education has established a set of guidelines that allow school districts to implement virtual learning days instead of losing instructional time by declaring snow days. This study investigated how school districts and their stakeholders have responded after implementing virtual learning day policies. The school districts

which have adopted virtual learning day policies expressed their satisfaction with virtual learning days as an alternative to declaring a snow day due to inclement weather. This approval was shared by shared by students, parents, teachers, and school administrators alike. Listed below is a summary of the survey findings:

1. All of stakeholders liked not having to make up days in response to traditional school cancellations due to inclement weather.
2. Increased proficiency with learning technologies has encouraged teachers to be more creative.
3. Students are engaged with the virtual learning resources.
4. Students like the flexibility and autonomy that virtual learning days provide.
5. Student self-discipline is enhanced based on the high degree of participation and work completion.
6. The primary concern of parents was that they were going to have to assume the role of teacher on virtual learning days.
7. The most commonly cited challenge to implementing virtual learning days was student Internet access from home.

The school districts in Indiana that have adopted virtual learning day policies agree that they are a better alternative than school cancellations due to inclement weather. They have also indicated that the increased efficacy with virtual learning technologies have had unforeseen benefits in the classroom as well. This investigation does not suggest that virtual learning should become a substitute for classroom learning. The major finding of this study is that virtual learning days serve as an option school districts can implement that may avoid the negative impact school cancellations can have on student learning outcomes.

References

Abdullah, M., Daffa, W. H., Bashmail, R. M., Alzahrani, M., & Sadik, M. (2015). The Impact of Learning Styles on Learner's Performance in E-Learning Environment. *International Journal of Advanced Computer Science and Applications*, *6*(9), 24–31. https://doi.org/10.14569/IJACSA.2015.060903

Bukhari, T. Z., Khan, J., Shahzadi, I., & Khalid, A. (2014). Mediating role of motivation to learn in determining e-learning outcomes: a Conceptual Study. *International Journal of Information, Business and Management*, *6*(2), 184–189.

Davies, J., & Graff, M. (2005). Performance in e-learning: online participation and student grades. *British Journal of Educational Technology*, *36*(4), 657–663. https://doi.org/10.1111/j.1467-8535.2005.00542.x

Ghirardini, B. (2011). E-learning methodologies - A guide for designing and developing e-learning courses. Food and Agriculture Organization of the United Nations. Retrieved from http://www.fao.org/docrep/015/i2516e/i2516e.pdf

Goodman, J. (2015). In Defense of Snow Days: Students who stay home when school is in session are a much larger problem. *Education Next, 15*(3). Retrieved from http://educationnext.org/defense-snow-days/

Hansen, B. (2008). School year length and student performance: Quasi-experimental evidence. *Unpublished Manuscript. University of California, Santa Barbara*. Retrieved from http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2269846

iNACOL. (2011, June). K-12 Online Learning: a smart investment now more than ever. iNACOL. Retrieved from http://www.inacol.org/wp-content/uploads/2015/02/a-smart-investment-now-more-than-ever.pdf

iNACOL. (2013, October). Fun facts about online learning. iNACOL. Retrieved from http://www.inacol.org/wp-content/uploads/2015/02/fun-facts-about-online-learning.pdf

Marcotte, D. E. (2007). Schooling and test scores: A mother-natural experiment. *Economics of Education Review, 26*(5), 629–640. https://doi.org/10.1016/j.econedurev.2006.08.001

Marcotte, D. E., & Hansen, B. (2010). Time for School? When the snow falls, test scores also drop. *Education Next, 10*(1). Retrieved from http://educationnext.org/time-for-school/

Marcotte, D. E., & Hemelt, S. W. (2007). *Unscheduled School Closings and Student Performance* (IZA Discussion Paper No. 2923). Institute for the Study of Labor (IZA). Retrieved from https://ideas.repec.org/p/iza/izadps/dp2923.html

McIntyre, E. (2016, January 15). Have e-days gained enough traction to usurp the snow day? *Education Dive*. Retrieved from http://www.educationdive.com/news/have-e-days-gained-enough-traction-to-usurp-the-snow-day/412069/

Morello, R. (2014, November 15). The "Virtual Option": Schools Prepare For Potential Snow Days. Retrieved from http://indianapublicmedia.org/stateimpact/2014/11/15/virtual-option-schools-prepare-potential-snow-days/

Pardamean, B., & Suparyanto, T. (2014). A Systematic Approach to Improving E-Learning Implementations in High Schools. *The Turkish Online Journal of Educational Technology, 13*(4). Retrieved from http://www.tojet.net/articles/v13i3/1333.pdf

Patall, E. A., Cooper, H., & Allen, A. B. (2010). Extending the School Day or School Year: A Systematic Review of Research (1985-2009). *Review of Educational Research, 80*(3), 401–436.

Phillips, J. (2014, February 6). "Blizzard bags" give kids school work during calamity days. *The Columbus Dispatch*. Retrieved from http://www.dispatch.com/content/stories/local/2014/02/06/blizzard-bags-fill-in-for-missed-days.html

Swetlik, Z., Graves, T., Hua, D. M., & Davison, C. B. (2015). Virtual Learning Strategies for Lost Instructional Time. *The CTE Journal, 3*(2), 15–27.

Approaching Machine Ethics: Topics in Technical Education

Christopher B. Davison

Ball State University

cbdavison@bsu.edu

Colin Allen

Indiana University

colallen@indiana.edu

Abstract
Machine ethics is a relatively new concept and is a growing topic of scientific exploration. As researchers seemingly move inexorably closer to human level performance, the ethical reasoning ability of machines has many concerned. Students in the technology domain, especially software engineers, are faced with increasingly complex situations in which their machine and software creations will be in a decision-making role. Often, those decisions will have ethical implications. The purpose of this article is to present strategies and classroom activities that will assist educators in teaching the concepts of machine ethics.

Introduction

Ethical considerations and applied ethics are commonplace in situations encountered by humans. However, machines too are increasingly placed in situations where ethical considerations are required. Even though current lethal weapon systems are not fully autonomous, they may be in the near future, and current systems possess degrees of autonomy which nevertheless entail the application of ethical principles. As machines become increasingly designed to operate for long periods without human intervention or interaction, their capacity to make ethical choices requires investigation. From ATMs to airline auto-pilots (Moor, 2006) machines are increasingly tasked in ways requiring ethical responsivities. Bill Gates, Elon Musk and many leading figures from the technology industry are alarmed at the thought of artificially intelligent systems without ethical processes (e.g. https://futureoflife.org/ai-open-letter). The current mixture of social, commercial, political, and philosophical issues creates a complex scenario for teaching machine ethics in a classroom.

The article begins by providing a literature review and definitions specific to ethics and machine ethics. This will set the context for the subsequent sections and the discussions therein. Following that, the importance of ethics and machine ethics is discussed. Finally, three classroom exercises are presented that will engage students in learning about machine ethics. Although we focus on the ethical capacities of machines

themselves, it is important to note that the machines are embedded in social-technical systems which themselves deserve ethical scrutiny, and the rapid growth of Artificial Intelligences (AI) and robotics has broad social and economic consequences, such as changes in the labor market, that we will not discuss here.

Definitions

Morality can be characterized as the aspect of human decision making and behavior that concerns the effects of agents' actions upon other sentient beings. In its most general sense, ethics is the branch of knowledge dealing with moral principles or behavior. Ethics can be divided into three branches of study: metaethics, applied ethics, and normative ethics. (See Lin, Abney, and Bekey 2011 for discussion of these three branches in the context of machine ethics.)

In metaethics, the basic concepts of ethics are explored. Metaethicists focus on the foundational definitions and root structure of ethical theory. Concepts such as "What is right and wrong?" are explored.

The field of applied ethics is concerned with the application of ethical constructs to real-world and near-future scenarios. An example of this is the ongoing discussion about robot warriors. Some researchers argue that this development should be encouraged because robotic warriors have the potential to perform more ethically on the battle field (Arkin, 2010) while others argue that it is wrong to even try to imbue some forms of ethical reasoning into machines (Tonkens, 2009). The privacy implications of technology provide another prolific point of discussion for applied ethics and within the Career and Technical Education domain (Davison, 2007).

Normative ethics is a branch of thought that discusses the source and standards for judgments about the rightness or wrongness of individual actions; it is the study of actions from an ethical perspective. This branch of ethics deals with the rightness or wrongness of actions according to various ethical theories. In the field of machine ethics, an example of a question in normative ethics is whether machines should be held to the same standards as humans, or perhaps to different, even higher standards.

One important approach to normative ethics is deontological ethics, or deontology. In deontology, the morality of an action is based upon rules. It is sometimes referred to as an ethical code. Because parallels between deontological rules and rule-based computational algorithms can be drawn, deontological ethics is a tempting approach for programmers attempting to infuse ethics into their machines.

Kantian ethics (Kantianism), is named after German philosopher Immanuel Kant. Kantianism is a form of deontological ethical theory. It is concerned with autonomy of decision making and adherence to moral law. Moral law is specifically formulated as the categorical imperative which states (in various formulations) that people should act only

in ways that their actions should become universal law—i.e., principles that all rational agents could follow without undermining the system of rational action.

Deontological approaches to normative ethics stand in contrast to consequentialist ethics. As the name "consequentialism" suggests, these ethical systems hold that actions should be evaluated by their outcomes. The particular motives or rationales for action are considered by consequentialists to have only derivative importance insofar as some rationales lead to better outcomes. Utilitarianism is the best-known form of consequentialist theory. Its major proponents, the philosophers Jeremy Bentham and John Stuart Mill argued that the maximization of overall pleasure or 'utility' was the sole criterion for moral evaluation. The idea of calculating utilities can also seem like a tempting approach for programmers, but there is the problem of exactly how to measure pleasure and suffering.

Machine ethics is defined as the implementation of moral decision making into computers, robots, and other autonomous devices (Allen, Wallach & Smit, 2006). Machine ethicists are concerned with the ethical reasoning of these machines and how, if possible, to imbue these machines with this reasoning ability.

A full moral agent is a being that is capable of knowing right and wrong and acting according to this capability. This type of agent is capable of making morally-based judgments.

An artificial moral agent (AMA) is an artificial agent that is computationally based, guided by norms, and implemented in software (Nagenborg, 2007). There exists a great deal of research within this domain. However, much like beating the Turing Test, it is not clear if creating an AMA that is a full moral agent is an achievable goal.

Literature Review

Ethics deals with right and wrong from a human perspective and an implied sense of morality. Until very recently only humans were concerned with ethical norms and standards of conduct. However, with the increasing complexity of technological systems, and increasing autonomy of the software controlling these systems, has come a growing realization that autonomous systems will need some kinds of ethical capacities (Allen, Varner & Zinser 2000; Georges 2003; Arkin 2010; Wallach & Allen 2009; Anderson & Anderson 2011; Lin, Abney, & Bekey 2011). Thus, the field of Machine Ethics has slowly emerged over the past two decades.

Georges (2003) coined the phrase "Digital Soul" to describe, among other aspects of AI, the ethical decision making capabilities, programmed or otherwise, of artificial moral agents. This phrase has evokes the idea of a Divine Command theory of morality: the belief that is common to many religious traditions that the source for moral standards for human behavior is to be found in the wishes or commands of one or more deities. By

analogy, the relationship of machines to humans may be one in which the source of machine morality should be human wishes and commands.

Only a small subset of the literature on machine ethics proposes a general architecture for artificial moral agents (e.g., Wallach, Franklin & Allen 2010) although efforts to build working prototypes are increasing (Anderson, Anderson & Armen 2006). As computational systems continue to increase in power and capability, the reciprocal need for AMAs will continue to increase.

There is no agreement among machine ethicists on the ethical framework that can and should be implemented into AMAs. Tonken (2009) argues that implementing a Kantian ethical framework would be *prima facie* anti-Kantian as it cannot support Kant's view on autonomy—the absolute freedom of rational agents to choose how to act. Challenges to this argument have been presented by other machine ethicists (White, 2015; Arkin, 2010) including the rationale for Lethal Autonomous Weapon Systems (LAWS). It is important to recognize that the philosophical meaning of "autonomy" is more tied up with issues of free will and consciousness than the engineering sense which refers to machines operating without direct human oversight (Wallach & Allen 2009).

Some researchers argue against the entire premise of machine ethics as "misguided" because of fundamental differences between the capacities of humans and AI (Yampolskiy, 2013, p. 389). Humans possess emotions, pain receptors, and feelings and it is not clear if those can or should be transferred to algorithms and computational machinery. There are many ethical frameworks, and considerable disagreement exists over ethical norms. For humans to agree upon *which* ethics to apply, let alone achieve agreement upon *how* to apply them, presents a difficult problem of building an ethical consensus.

There are a number of significant challenges in creating a fully capable ethical system including emotions (e.g., empathy and compassion) and implementation of a broader range of mental states (Sparrow, 2009). There is no clear correct way to build an AMA. It would appear that an autonomous system, in the engineering sense, imbued with ethical governors – i.e., dedicated systems geared towards a particular context of use (Arkin 2010; Kinne & Stojanov, 2016) is the approach that is feasible with current technology.

Importance of Learning Ethics and Machine Ethics

Some scholars argue that machine ethics do not or cannot exist. Some of these arguments are based on skepticism about the idea of "Strong AI", i.e. fully conscious, human-equivalent AI. Searle (1980) argues that computer programs could never possess "intentionally" (p. 417) and thus Strong AI could not exist without duplicating human brains. Some argue that machines do not have free will and a sense of self, and therefore, could not become an AMA. However, due to the increasing capability and sophistication of machines, coupled with their increased role in ethically challenging situations, to ignore machine ethics would be short-sighted.

Elon Musk (Telsa Motors) has characterized AI as one of the biggest existential risks facing humanity. He and Sam Altman (startup incubator entrepreneur) have collectively formed OpenAI in 2015. This is a research startup company with the goal of promoting non-harmful AI. The company was pledged $1B (USD) in funding to open source AI development. The human survival strategy the company is pursuing is one of more AI will equate to more good. Musk believes that if AI is everywhere with everyone, then the odds of a malevolent AI in the hands of a few will be diminished. He also acknowledges the possibility of creating the very thing he intends to preclude (Markoff, 2015).

Other noteworthy people are concerned about the threat humankind faces with Strong AI. Bill Gates is concerned and has stated he agrees with Elon Musk regarding the threats posed by super intelligent machines. Stephen Hawking is concerned that Strong AI could spell the end of the human race. Hawking and Musk are both signatories on the "Future of Life" letter written and sponsored by the Future of Life Institute.

Another aspect to the importance of machines ethics is known as the Technological Singularity, or more simply, the Singularity. The Singularity, the term attributed to John von Neumann, is the runaway self-improvement cycles of machine learning. As machines learn and improve, it is hypothesized that their self-improvement cycles will escalate and trigger a self-improvement explosion resulting in a super intelligence of which humans cannot compete. While it is impossible to predict what human life will entail in the post-Singularity world, the thought of an amoral super intelligent system makes a strong case for teaching Machine Ethics.

Classroom Activities

The following three classroom activities are designed to engage students in the exploration of ethics and machine ethics. While there is no *a priori* knowledge of ethics of machine ethics is assumed; basic computer, mathematics, and proficiency with personal computers is required. These activities are meant to build upon each other. The first is an exercise designed to assist students in understanding ethics from a human behavioral perspective. The second is an activity that will assist students in learning about machine ethics.

Learning Objectives

1. Students will demonstrate knowledge of ethics and machine ethics.
2. Students will compare and contrast ethics and machine ethics.
3. Students will synthesize and evaluate theoretical approaches to machine ethic implementations.

Required Materials

1. Computer with Web Browser

2. Internet Connectivity

Classroom Exercises

1. Moral Philosophy and Ethics.
    a. The instructor begins the discussion on "What is ethics?" and shares information regarding the theory of ethics and define/discuss the following (see above definitions):
        a. Meta-Ethics
        b. Normative Ethics
        c. Applied Ethics
    b. Students may review the literature on the Internet for further information and discussion on ethical theory.
    c. Students are organized into two teams (may be subdivided for large classes). Team 1 will defend the view that ethics can be engineered into machines. Team 2 will defend the view that ethics is not something that can be engineered. Team members discuss their best argumentative strategy.
    d. A classroom debate is held between the two teams.

2. Machine Ethics.
    a. The instructor explains basic machine ethics concepts including moral agency, and AMA.
    b. Students compare and contrast machine ethics versus human ethics.
    c. Groups of students are first tasked with brainstorming about *past unexpected/unintended* consequences of AI innovations – for example, ways in which AI has changed social media, or finance markets.
    d. Groups are then tasked with brainstorming about *future unintended* consequences of AMAs. Examples: If autonomous military robots are described as having ethical governors, will this make war more likely, or will it change the nature of warfare in ways that may be difficult to anticipate? Will self-driving cars that stop more readily for pedestrians and are less likely to run them over than human drivers, make pedestrians more likely to disrupt vehicular traffic? Will AMAs make reduce or otherwise affect personal privacy in unintended ways?

3. Implementation of Ethics in Technology
    a. The instructor tasks the class to provide ethical algorithms for the following scenarios:
        i. Human Privacy Preservation. An autonomous drone searching for terror suspects. The drone has an array of sensors including optical, acoustic, and thermal imaging. How can the drone carry out its mission and yet still preserve the law-abiding citizens' right to privacy?

ii. War fighting. Robotic war fighters, Arkin's (2010) lethal autonomous unmanned systems, are a large topic of discussion. Is it possible to engineer better-than-human ethical decision making? What would those algorithms look like? Should there be "divine commands" such as those postulated by Bringsjord,and Taylor (2015)?
iii. Elder care robots: How should a robot be designed to balance a duty of care against the individual's right to autonomously refuse medications (cf. Anderson, Anderson & Armen 2006).
iv. Autonomous vehicle: A passenger orders a self-driving car to drive 30% over the speed limit because of a medical emergency. Design an algorithm to determine whether the car should obey.

Conclusion

In this article, the concepts of ethics, machine ethics, and AMAs were discussed. A review of the literature was presented that outlined human ethics, definitions of ethics and definitions of machine ethics. Following the literature review, the importance of teaching and learning machine ethics was discussed. Finally, three classroom exercises were presented to assist educators in teaching machine ethics in their classrooms.

References

Allen, C., Wallach, W., & Smit, I. (2006). Why machine ethics? *IEEE Intelligent Systems*, *21*(4), 12-17.

Allen, C., Varner, G., & Zinser, J. (2000). Prolegomena to any future artificial moral agent. *Journal of Experimental & Theoretical Artificial Intelligence*, 12, 251 – 261.

Anderson, A. & Anderson, S. (2001). *Machine Ethics*. Oxford: Oxford University Press.

Anderson, M., Anderson, S. L., & Armen, C. (2006). An approach to computing ethics. *IEEE Intelligent Systems*, *21*(4), 56-63.

Arkin, R. C. (2010). The case for ethical autonomy in unmanned systems. *Journal of Military Ethics*, *9*(4), 332-341.

Bringsjord, S. & Taylor, J. (2011). *Introducing divine command roboethics*. In Lin et al. (Eds.), 85-108.

Davison, C. B. (2007). Ethics of business continuity and disaster recovery technologies: A conceptual Orientation. *International Journal of Computers, Systems and Signals, 8*(1), 54-63.

Georges, T.M. (2003). *Digital soul: Intelligent machines and human values*. Cambridge: Westview Press.

Kinne, E., & Stojanov, G. (2016, March). Grounding Drones' Ethical Use Reasoning. In *2016 AAAI Spring Symposium Series.*

Lin, P., Abney, K., & Bekey, G. A. (2011). *Robot ethics: the ethical and social implications of robotics*. MIT press.

Markoff, J. (2015, December). Silicon Valley investors to bankroll artificial-intelligence center. *The Seattle Times.* Retrieved from:

http://www.seattletimes.com/business/technology/silicon-valley-investors-to-bankroll-artificial-intelligence-center/.

Moor, J. H. (2006). The nature, importance, and difficulty of machine ethics. *Intelligent Systems, IEEE 21*(4):18-21.

Nagenborg, M. (2007) "Artificial moral agents: an intercultural perspective." *International Review of Information Ethics* 7(9), 129-133.

Searle, John. R. (1980) Minds, brains, and programs. *Behavioral and Brain Sciences 3*(3), 417-457.

Sparrow, R. (2009). Building a better WarBot: Ethical issues in the design of unmanned systems for military applications. *Science and Engineering Ethics*, *15*(2), 169-187.

Tonkens, R. (2009). A challenge for machine ethics. *Minds and Machines, 19*(3), 421-438.

Wallach, W., & Allen, C. (2010). *Moral Machines: Teaching Robots Right from Wrong.* Oxford: Oxford University Press.

Wallach, W., Franklin, S. & Allen, C. (2010). A Conceptual and Computational Model of Moral Decision Making in Human and Artificial Agents. *Topics in Cognitive Science* 2(3), 454-485.

White, J. (Ed.). (2015). *Rethinking Machine Ethics in the Age of Ubiquitous Technology*. IGI Global.

Yampolskiy, R. V. (2013). Artificial intelligence safety engineering: Why machine ethics is a wrong approach. In *Philosophy and Theory of Artificial Intelligence* (pp. 389-396). Springer Berlin Heidelberg.