

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

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### **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. SEIRI provided evaluation and assessment services for K-12 and post-secondary STEM educational grants, including federal, state and local funded projects, statewide. Finally, SEIRI 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.

- 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
	1 <sup>st</sup>	2 <sup>nd</sup>	3 <sup>rd</sup>	
	QTR	QTR	QTR	
	SPR	SUM	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
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	QTR	QTR	QTR	
	SPR	SUM	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 *expository* 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](http://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:

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

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***

<b>Adjusted Score</b>	<b>Grade Level</b>
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 9<sup>th</sup> and 10<sup>th</sup> grade reading levels; the second highest number of lessons (24%) were written at the 11<sup>th</sup> and 12<sup>th</sup> grade reading levels; and the third highest number of lessons (23%) were written at the 7<sup>th</sup> and 8<sup>th</sup> 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<sup>th</sup> grade level, one at the 7<sup>th</sup>, one at 8<sup>th</sup>, two at 9<sup>th</sup>, and one at the 12<sup>th</sup> 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 12<sup>th</sup> 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).

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