Assessment Beyond Classroom

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Abstract

This paper presents a research study to incorporate Artificial Intelligence (AI) tools into Civil Engineering (CE) and Electrical/Computer Engineering (ECE) undergraduate curriculum at Texas Southern University. The infusion of innovative ECE specialized AI tools into traditional CE problem-solving routines by problem-based learning (PBL) approach was designed to enhance engineering students' problem-solving and critical thinking skills, expose them to new technology, prepare them for diverse and multidisciplinary workforce requirement. In the process of the implementation, multiple assessments have been used to measure student success for both academic content knowledge and broader competencies beyond classroom. The multi-dimensional assessments included direct assessments to evaluate student learning activities, an indirect assessment to collect student feedback as well as the national Course-based Undergraduate Research Experience survey to find out student learning performance as compared to the national level in STEM field. The collected data have been used strategically to make project expansion, enhance teaching quality and improve student learning both in and beyond classroom.

I. Introduction

Texas Southern University (TSU) is located at Houston, the fourth largest city in US. TSU is ranked as the second nation's largest HBCU (Historically Black College and University) by enrollment with 12 colleges and schools and offering more than 100 undergraduate and graduate programs and concentrations. College of Science, Engineering & Technology has the largest enrollment every year and educates students with knowledge and skills for the job market. The National Science Foundation created a grant program HBCU-UP (Historically Black Colleges and Universities Undergraduate Program) to enhance the quality of science, technology, engineering and mathematics (STEM) instructional and outreach programs at HBCUs as a means to broaden participation in the Nation's STEM workforce. This research project has been funded for four years from 2016-2019 by the National Sciences Federation to infuse Artificial Intelligence (AI) tools into Civil Engineering (CE) and Electrical/Computer Engineering (ECE) undergraduate curriculum at Texas Southern University. The infusion of innovative ECE specialized AI tools into traditional CE problem-solving routines by problem-based learning (PBL) approach was designed to enhance engineering students' problem-solving and critical thinking skills, expose them to new technology, prepare them for diverse and multidisciplinary workforce requirement. It also helps bridge current curricula gap in the Department of Engineering at TSU. The objectives of the project are: 1) to develop an intelligent knowledge database to document, compare, and analyze cutting-edge AI applications in civil engineering field, which can be used as the platform and educational media for curricula development and implementation for PBL approaches in classroom; 2) to add one new interdisciplinary course to the Department's curricula "AI Tools for Engineering Problem Solving" for all senior engineering major students; 3) to enrich current curricula by integrating innovative AI application case studies into more than fourteen existing courses being offered in the Department, 4) to foster interdisciplinary academic setting by hosting server-based intelligent database in the College of Science, Engineering and Technology and to provide web- and classroom-based workshops and tutorials to all interested students and faculty; and 5) to support undergraduate students' early involvement in research.

One of the main goals of the project is to promote learning beyond classroom by fostering interdisciplinary academic settings and to support undergraduate students' early involvement in research. In the process of the implementation, four undergraduate courses in two academic programs have been selected in Spring of 2018 as pilot studies: Civil Engineering (course number identified with prefix CIVE) and Electrical/Computer Engineering (course number identified with prefix CMET):

Freshmen level core course: CIVE141 Civil Engineering Materials. The course is being offered twice per year.
Sophomore level core course: CIVE 224 Geotechnical Engineering. The course is usually being offered once per year in Spring.
Senior level core course: CIVE 339 Reinforced Concrete Design. This class was originally offered once per year in the Fall semester, but due to increased interests and enrollment from junior senior students it was offered in Spring of 2018 as an addition.
Junior/Senior level elective course: CMET 438 Artificial Intelligence. This course is being offered once per year in the Spring.

Student learning is affected by different factors. It is very essential to collect precise and wide-ranging assessment data from difference sources in order to make effective improvements in course design and instructional quality to enhance student learning. In order to expand assessment strategies beyond classroom, which include competencies such as the student outcomes specified in Accreditation Board for Engineering and Technology (ABET) criterion 3a-3k[1]:

An ability to function on multidisciplinary teams
An ability to identify, formulate, and solve engineering problems
An ability to communicate effectively
The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
A recognition of the need for, and an ability to engage in life-long learning
A knowledge of contemporary issues
An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

These competencies are not "knowledge" that can be captured in traditional tests. A series of assessment activities were carefully designed aiming to effectively measure student success for both academic content knowledge and broader competencies beyond classroom.

A good assessment practice shifts the focus from blaming students for not achieving expected learning outcomes to finding out true reasons behind student learning issues. The grant project implemented multi-dimensional assessments. Student learning outcomes are evaluated through direct assessments in course assignments, projects, group activities, quizzes and exams, and student grades have been used to analyze student class performance at the same time to provide meaningful information for course improvements. In addition to the direct assessments in class, two indirect assessments have been conducted to collect data on student learning in and beyond classroom from their perspective. Both indirect assessments used survey method. The Research on the Integrated Science and Engineering Curriculum (RISEC) survey was developed in-house. This survey is specifically targeting at student learning and using the AI tools in their hands-on projects and research activities to find out 1) student engagement and interaction in the process of learning, 2) student research and problem solving skills, 3) student feedback on how the artificial intelligence infusion project contributed to their course contents learning, and 4) student open feedback on overall effectiveness of instructional delivery and project implementation. The second survey is the Classroom Undergraduate Research Experience (CURE) survey, which has been used nationwide to measure student experiences in "research-like" or other science courses. In this project, CURE data is used as a bench mark to compare TSU students with nationwide students in STEM field in science attitude, learning experiences, learning gains, learning benefits and overall evaluation of the course. The survey results give the instructor an opportunity to find out the course teaching effectiveness, and more importantly to compare TSU students with national counterparts in academic performance. The additional value of these surveys is to find out the impact of AI infusion on student learning and their future career. The indirect assessment data contribute to the project's success in several aspects. Firstly, the data have been used to make instructional improvement, secondly, student feedback provided very important information for AI project expansion, thirdly the data help the instructor to compare the performance of TSU students with national peer in STEM field, and lastly, the data provide evidence of the impact of AI tools on student learning beyond traditional classroom knowledge.

II. AI Infusion to Promote Learning beyond Classroom

The overarching technical justification for integrating state-of-the-art AI tools with state-of-the-practice engineering methods is the rapid advancement in AI technologies, which has made it a powerful and ubiquitous solution for many complex engineering problems. The Engineering Department of TSU has two majors: CE and ECE. Currently CE curricula focus exclusively on conventional mathematics, physics, and/or engineering methods for core engineering courses, and these classical curricula are highly specialized in solving different types of problems such as optimization, simulation, prediction, modeling, diagnosis, design to name a few. On the other hand, ECE major students learn AI theories and algorithms in depth but lack real case engineering applications in their curriculum to fully appreciate the knowledge they are learning. As pointed out by famous educator Malcolm Knowles, adults learn best when they understand why something is important to know. Hence four courses were selected as pilot studies to promote students learning outcomes. Figure 1 depicts the flowchart of the pilot studies. Three representative CE core courses at different levels (freshmen CIVE 141, sophomore CIVE 224 and junior/senior CIVE 339) and one junior/senior level ECE elective course (CMET 438) were selected for the implementation.

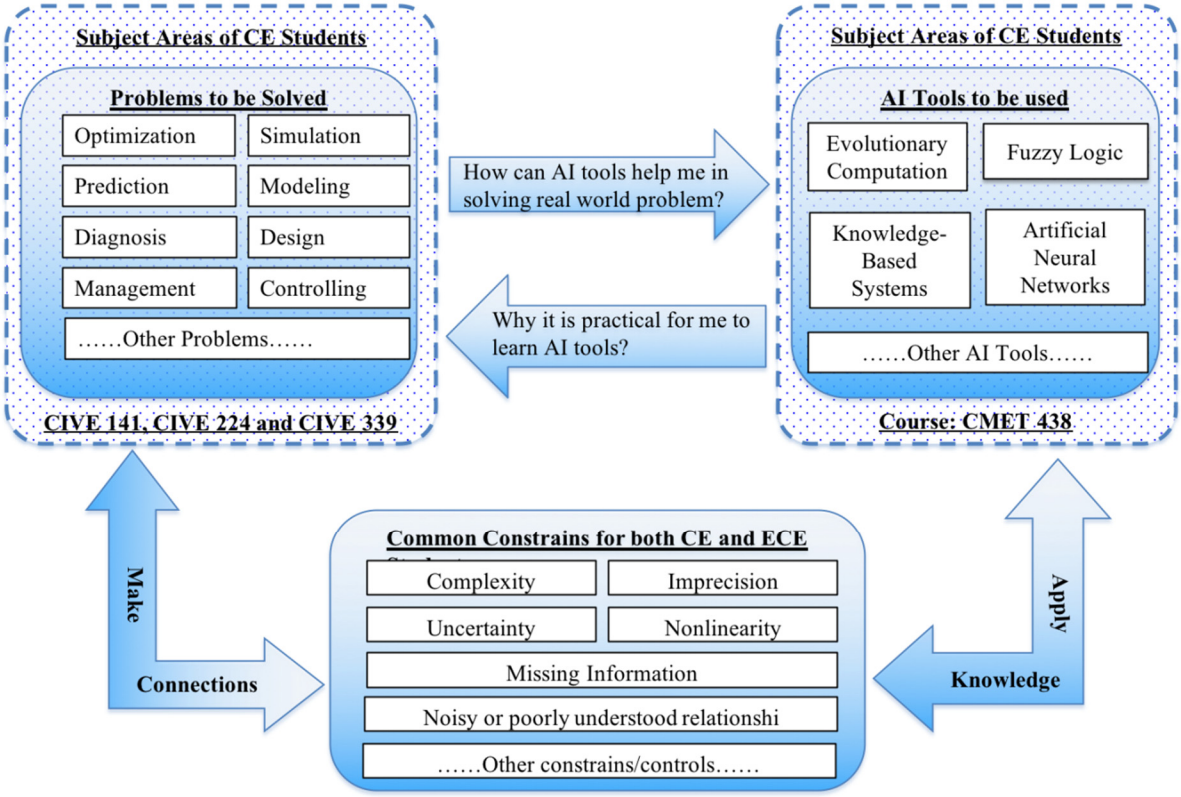

Figure 1. *AI Infused Curriculum Implementation Flowchart*

For the three CE courses, AI infused curricula were introduced in three phases: firstly, a self-developed intelligent database was used to help students learn the basics of commonly used engineering thinking strategies, their state-of-the-art counterpart of AI assisted strategies and specific domain knowledge relates to each individual course; secondly, one or two carefully selected case studies were presented to each class with group discussions, both in class and through blackboard discussion board to guide students learn how to explore alternative candidates and search for solutions; lastly, by the end of the semester a hands-on term project was then assigned to each class. According to National Survey of Student Engagement (NSSE), a leading authority dedicated to improving undergraduate education, such curriculum has the pedagogical merit of engaging undergraduates in more in-depth thought which will provide undergraduate students greater educational and personal gains[2].

For the ECE course, adoption of knowledge automation software called CORVID was added as term project. As students in this class are required to learn Expert System, one of the widely used AI paradigms, the automation software aims to provide students hands-on experience to apply AI theories in representing, searching and capturing intelligence, which is often considered the most important part of any successful AI applications.

The initiation of these research-supportive curricula in the Department for undergraduate students' early involvements in research is to enhance students' professional and personal development, career preparation, and general skill development. The Council on Undergraduate Research (CUR) pointed out the growing recognition of the value of integrating research and scholarship into the undergraduate curricula include: help students with their career choices, develop skills that are not taught in the standard university curriculum, greatly improve communication and problem-solving skills, and much more[3].

III. Assessment beyond Classroom

At the classroom level, a range of assessment strategies can be used to understand students' growth in these areas. The direct assessment of students' course grades were the accumulation grades of assignments, projects and exams. Course grades from all four courses were collected. These data, once accumulated for more than one semester, will provide very effective assessment to check student in-class performance with the instructor's expectation as well as student learning and project goals. However, it is the indirect assessment activities that not only provided students great opportunities for constructive feedback , suggestions for instructional improvement, and their learning experiences beyond classroom but also make students feel respected in the process of learning.

Assessment of competencies beyond classroom is very necessary to provide relevant, specific information about undergraduate engineering student learning in the aforementioned vital areas specified by ABET 3a-3k. It is possible to assess these competencies at a jurisdictional level, the two level surveys used in this research provided quantified information about complex competencies.

a. RISEC Survey Results

Two indirect assessments have been strategically incorporated in the project as mentioned earlier. At the end of the semester, students were asked to take the RISEC survey to provide feedback specific regarding their learning experiences of AI infused curriculum. RISEC survey has three sections; the first section is collecting the data about student learning engagement and interaction related to learning activities and assignments; the second section is about student learning outcomes related to the research components and the use of the AI tools; and the last section is open responses from students regarding the overall class quality and recommendations. The following data summarized RISEC data collected from four different level classes in 2018 spring semester: CIVE 141, CIVE 224, CIVE 339 and CMET 438. The participation rates for this voluntary survey are: 26%, 78%, 32% and 89% respectively. In the following tables, N stands for number of participants in the particular class, E stands for total enrolled students. Results shown here are the positive (very much, quite a bit) responses. There was no negative response received in all four classes, and very small percentages of neutral responses. The neutral and negative responses are omitted for brevity.

Table 1 through Table 3 summarized selective RISEC questions related to three types of assessment: Table 1 - Student engagement and interaction in the process of learning; Table 2 - Student research and problem solving skills, with emphasis on mental activities; Table 3 - Student feedback on how the artificial intelligence infusion project contributed to their broader abilities in and beyond classroom.

The AI infused curriculum introduced a collection of different AI tools and their applications in real engineering applications. These are the situations in which students can make connections between classroom activities and reality. This connection creates an optimal learning environment to increase student learning interest and drive their motivation that links to their goals in academic achievement and professional career in their future. Following observations can be made from student's feedback In Table 1:

For freshmen level CE core course (CIVE 141), 100% students reported engaged in learning, and the AI infusion not only helped their understanding of the content knowledge, but also increased their interest in future research. They also reported integrating ideas, concepts and information from various sources.

The sophomore level CE core course (CIVE 224) has higher participation rate compared to the other CE courses. 100% students reported the implementation improved their understanding of the contents and such also increased their interest in the subject matter.

For the junior/senior CE core course (CIVE 339) engagement to the learning process, better understanding of the content and increased interests were evidenced by 100% positive feedback.

The ECE program junior/senior elective course (CMET 438) has the highest participation rate. All assessment questions related to student engagement and interaction received above 70% positive feedbacks. However, it lacks unanimously agreed learning gains from students but shows a more even across the board improvement.

Table 1. *Student Engagement / Interaction Related to Learning Activities and Assignments*

Selected Assessment Questions	CIVE 141		CIVE 224		CIVE 339		CMET 438	
	N=7	E=27	N=21	E=27	N=6	E=19	N=17	E=19
	Very much	Quite a bit	Very much	Quite a bit	Very much	Quite a bit	Very much	Quite a bit
The activities/assignments in this class engaged me in the learning process.	43%	57%	85%	14%	67%	33.0%	71%	12%
The activities/assignments in this class helped me improve my understanding of the content knowledge.	57%	43%	76%	24%	50%	50%	77%	12%
My interest in the subject matter has increased due to the activities/assignments in this class.	43%	43%	62%	38%	33%	50%	53%	29%
My interest in future research has increased due to the activities/assignments in this class.	86%	14%	68%	24%	50%	50%	47%	29%
I was motivated to do more than the minimum requirements in this class.	71%	14%	57%	38%	33%	50%	59%	12%
I worked on a project that required integrating ideas or information from various sources.	71%	29%	62%	33%	33%	50%	65%	18%
I put together ideas or concepts from my other courses when completing assignments or during class discussions.	29%	71%	48%	38%	50%	33%	71%	12%

The last five questions in RISEC survey section one ask the coursework emphasis on the mental activities, intending to find out if students had increased the ability of knowledge application through analyzing, synthesizing, making judgement and applying theories to solving practical problems both in and beyond classroom setting. See Table 2 below. Following observations can be made from student's feedback In Table 2:

For freshmen level CE core course (CIVE 141), the coursework's major emphasis on mental activities are memorizing facts, ideas or methods, analyzing basic elements and applying theories or concepts to practical problems or in new situation100% students reported engaged in learning, and the AI infusion not only helped their understanding of the content knowledge, but also increased their interest in future research. They also reported integrating ideas, concepts and information from various sources.

For the sophomore level CE core course (CIVE 224) 100% students reported the emphasis was on analyzing idea, experiences or theory.

For the junior/senior CE core course (CIVE 339) 100% students reported the emphasis lies both on memorizing facts, ideas, methods and analyzing basic elements of ideas, experiences or theories.

The ECE program junior/senior elective course (CMET 438) reported a pretty even emphasis on all five mental activities with above 88% positive feedbacks.

These data indicate that the coursework and learning activities are in alignment of project and teaching objective, which is to train students to use knowledge and skills to solve practical problems.

Table 2. *Coursework Emphasis on Mental Activities*

Selected Assessment Questions	CIVE 141		CIVE 224		CIVE 339		CMET 438	
	N=7	E=27	N=21	E=27	N=6	E=19	N=17	E=19
	Very much	Quite a bit	Very much	Quite a bit	Very much	Quite a bit	Very much	Quite a bit
Memorizing facts, ideas, or methods from your courses and readings so you can repeat them in pretty much the same form.	71%	29%	29%	67%	67%	33%	59%	35%
Analyzing the basic elements of an idea, experiences, or theory, such as examining a particular case or situation in depth and considering its components.	71%	29%	52%	48%	67%	33%	65%	29%
Synthesizing and organizing ideas, information, or experiences into new, more complex interpretations and relationships.	43%	43%	52%	43%	33%	50%	59%	29%
Making judgments about the value of information, arguments, or methods, such as examining how others gathered and interpreted data and assessing the soundness of their conclusions.	57%	29%	43%	48%	50%	33%	53%	41%
Applying theories or concepts to practical problems or in new situations.	57%	43%	69%	33%	33%	50%	53%	41%

One of the main goals of the project is to promote learning beyond classroom by fostering interdisciplinary academic settings and to support undergraduate students' early involvement in research. In the first section, more than 83% of the students reported that their research interest increased due to the class activities and assignments. More than 82% of the students also reported that the class activities required integrating ideas, information, concepts, and theories from various sources out of their own classroom settings.

The second section of student survey is focusing on collecting data (Table 3) on student research skills related to the use of AI tools from their own learning experiences. Following observations can be made from student's feedback In Table 3:

For freshmen level CE core course (CIVE 141), more than 86% students indicated an overall improvement in their abilities in research related competencies. The freshmen students particularly reported 100% positive in the following abilities: utilize different knowledge source other than textbook, awareness of the responsible conduct of being an engineer/researcher and use new tools/algorithms/software to solve a given problem.

For the sophomore level CE core course (CIVE 224) more than 86% students reported the implementation of the AI infused curricula helped very much or quite a bit on all abilities assessed in the RISEC survey. Particularly 100% positive in their ability to develop problem solving plans and articulate research findings through written assignments, final products, and/or oral presentations.

For the junior/senior CE core course (CIVE 339) five out of the ten assessed abilities received 100% positive feedback: with the infused AI case studies and term project, students reported their competencies improved very much or quite a bit in identifying basic principles and core knowledge, the engagement helped them in making connections between this course to other engineering courses, in utilizing different knowledge sources outside their textbook and in using new tools/algorithms/software to resolve a particular problem at hand.

The ECE program junior/senior elective course (CMET 438) reported a pretty even positive improvement in all ten abilities assessed with above 82% positive feedbacks.

Table 3. *Student Feedback on Research Knowledge and Skills Related to the Use of AI Tools*

Selected Assessment Questions	CIVE 141		CIVE 224		CIVE 339		CMET 438	
	N=7	E=27	N=21	E=27	N=6	E=19	N=17	E=19
	Very much	Quite a bit	Very much	Quite a bit	Very much	Quite a bit	Very much	Quite a bit
Your ability to "identify basic principles and knowledge related to core material".	74%	14%	57%	38%	67%	33%	77%	12%
Your ability to "make connections between this course to other engineering courses"	43%	43%	43%	48%	17%	83%	53%	41%
Your ability to "develop a plan to address or resolve a specific question or problem."	29%	57%	52%	48%	67%	17%	59%	35%
Your ability to "collect and interpret data and information in an attempt to resolve the question or problem."	71%	14%	57%	38%	50%	50%	65%	24%
Your ability to "analyzing different scenarios and finding the best solution."	71%	14%	52%	33%	67%	17%	53%	35%
Your ability to "trouble shoot your solutions"	43%	43%	43%	48%	17%	67%	59%	24%
Your ability to "utilize different knowledge source other than textbook related information to solve a question or problem"	57%	43%	53%	33%	83%	17%	77%	18%
Your "awareness of the responsible conduct of being an engineer/researcher."	71%	29%	33%	62%	50%	33%	77%	18%
Your ability to "use new tools/algorithms/software to solve a problem"	71%	29%	62%	33%	50%	50%	59%	35%
Your ability to "articulate your research findings through written assignments, final products, and/or oral presentations."	43%	43%	71%	29%	50%	33%	59%	35%

The division of courses tends to isolate knowledge from one course to another. Isolated knowledge creates a barrier to understand the real nature of the problem. It narrows down the possibilities, opportunities and abilities to solve the problems. In reality, everything is interconnected through one way or another. It is extremely important for students to make connections of knowledge between different courses and with the real world. AI tools build a learning environment that facilitates students to make the connection of knowledge with real world.

The authors believe AI application infusions are particularly helpful for junior/senior engineering students facing complex questions that mimic real world engineering problems such as design, planning, diagnosis, classification, management, and decision making scenarios. The RISEC results of AI infused curricula are affirmative and very positive in enhancing students learning experiences both in and beyond classroom.

In the open section of student feedback, ninety-five percent of students think it is important to introduce AI knowledge in the course, ninety percent of students reported that AI tools are very efficient in comparison to the traditional methods in the process of solving problems. The data analysis from RISEC survey is instrumental to the instructional improvement and project expansion. Students provided very positive feedback on AI integration, learning activities and improved research skills, which confirmed AI infused curriculum has positive impact not only on academic content knowledge but also on broader competencies beyond classroom.

b. CURE Survey Results

The second indirect assessment uses Classroom Undergraduate Research Experience (CURE) national survey. CURE survey "grew out of a creative collaboration of faculty from Grinnell College, Hope College, Harvey Mudd College, and Wellesley College. The CURE may be used as a pretest-posttest or posttest-only survey to measure student experiences in "research-like" or other science courses" (Grinnell College) [4]. It is licensed under a Creative Commons Attribution-Non Commercial-Share Alike 4.0 International License, copyright 2005-2018 Grinnell College. The survey has three components, 1) a pre-course survey including demographic questions, reasons for taking the course, level of experiences on various course elements, science attitude and learning style questions, 2) a post-course survey including estimation of learning gains in the course elements, estimation of learning benefits, overall evaluation of the experience and science attitude, and 3) a brief survey for the course. In this project, CURE survey is used as a tool to collect bench mark data to compare TSU students with Nation-wide students in STEM field, and to measure students learning outcomes related to undergraduate research experiences and investigates various elements related to student learning involving the use of AI tools.

The CURE surveys were conducted in Spring 2018 semester to three CE courses: freshmen level CIVE 141, sophomore level CIVE 224 and junior/senior level CIVE 339. The pre-survey was conducted before AI infused content was introduced and post-survey was conducted during the last week of the semester, after all curriculum content was completed. Similar positive results were reported from all three courses. For brevity, reported data collected from junior/senior level course CIVE 339 are presented here with a total enrollment of 19 students, 14 male students and 5 female students and 95% of them are seniors. Students participated in both pre-course and post-course surveys voluntarily. All students participated in both pre and post surveys. For the sections of course elements, course benefit, and attitudes toward science, CURE analyst provided TSU with mean data. So, the data analysis method of Independent-Samples T Test is used to compare TSU mean results with that of national data to find out statistical significance with the confidence level set at 95%.

In the pre-course survey, there is a question of ten reasons to take the course for students to rank. The top six reasons for TSU students to take the course are listed in Table 4, which indicate student's expectation for the course. Besides needing the course to fill a major requirement, students wanted to learn about science and research process through hands-on research experience for desired employment after college.

Table 4. *Top Six Very Important Reasons to Rake the Class*

No.	Reasons to take the course	%
1	I need it for graduate or professional school.	65%
2	To fill a distribution requirement	63%
3	I need it for my desired employment after college.	61%
4	To fill a requirement for my major	58%
5	To learn about science and the research process	58%
6	To get hands-on research experience	53%

In the pre-course survey, students were asked to assess their prior experience on 25 course elements, and in the post-course survey, students were asked the same course elements to rate their gains they have made as a result of taking the course. TSU students showed their improvements in 21 out of 25 course elements, a coverage of 84% overall, which is higher than the Nation-wide results of 19 out of 25 course elements, which is 76%. The mean comparison result from Independent-Samples T Tests between TSU pre-course experience and post-course gains generates a P=0.000, which is statistically extremely significant, see Table 5 below. When compare TSU students' post-course gains with nation-wide post-course gains, again, the Independent-Samples T Tests generates P=0.000, see Table 6 below.

Table 5. *Mean Comparison of TSU Pre-course Experience and TSU Post-course Gains*

Groups	Elements	Mean	Std. D.	t	df	Sig. (2-tailed)
TSU Pre-course Experience	25	3.6944	0.16169	-5.999	48	0
TSU Post-course Gains	25	3.9704	0.16362			

Table 6. *Mean Comparison of TSU Post-course Gains and Nation-wide Post-course Gains*

Groups	Elements	Mean	Std. D.	t	df	Sig. (2-tailed)
TSU Post-course Gains	25	3.9704	0.16362	5.525	48	0
Nation-wide Post-course Gains	25	3.616	0.27588			

The top six post-course gains reported by TSU students are listed below. These knowledge and skills are directly associated with student ability to conduct research through the use of computer technology and to produce research results.

1. A project where students have input into process or topic
2. A project entirely of student design
3. Work on problem sets
4. Computer modeling
5. Present results in written papers or reports

There are twenty-one items that are measured in the post-survey for learning benefits from the course. TSU students had 17 (81%) items scored higher than Nation-wide data. The Independent-Samples T Test generated P=0.000, which is statistically extremely significant. See Table 7 below.

Table 7. *The Mean Comparison of Course Benefits between TSU Students and Nation-wide Students*

Groups	N	Mean	Std. D.	t	df	Sig. (2-tailed)
TSU	21	3.8914	0.14427	5.195	40	0
Nation-wide	21	3.6043	0.20822			

The top six benefits reported by TSU students from the course are as listed below. AI infusion not only prepares students to be technologically competitive in either careers, but also increases students' self-confidence that will help them achieve greater successes in all aspects of their life.

1. Clarification of a career path
2. Confidence in my potential to be a teacher of science
3. Ability to read and understand primary literature
4. Learning to work independently
5. Skill in how to give an effective oral presentation
6. Self-confidence

In the section of science attitudes, students were asked 22 questions in both pre-course and post-course surveys. TSU students reported 17 (77%) items with positive changes. In mean comparison of TSU student pre-course to post-course science attitude, The Independent-Samples T Test generated P=0.014, which is statistically significant. See Table 8 below. This course has enhanced students' concept of science knowledge and also further strengthened their science attitudes.

Table 8**.** *The Mean Comparison of TSU Student Science Attitude Change in Pre and Post-course Surveys*

Groups	N	Mean	Std. D.	t	df	Sig. (2-tailed)
Pre-course Science Attitude	22	3.5945	0.35626	-2.551	42	0.014
Post-course Science Attitude	22	3.8509	0.76261			

In the post-course survey, there are four questions that serve as an overall assessment of the course. The following table 9 shows the results of TSU students' rating for the course.

Table 9. *Overall Course Rating by TSU Students*

No.	**Rating Questions**	**Strongly Agree**
1	This course was a good way of learning about the subject	83%
2	This course was a good way of learning about the process of scientific research	84%
3	This course had a positive effect on my interest in science	80%
4	I was able to ask questions in this class and get helpful responses	84%

The CURE survey results from TSU students are very affirmative and positive. Students expressed their expectation of taking this course, which is to learn about science and research process through hands-on research experience for desired employment after college. In the survey, they provided strong evidence that AI infusion did impact their knowledge acquisition and research ability improvement demonstrated in their report in learning experience enhancement, knowledge gains and course benefits. AI infusion is a very well-timed project that prepares TSU students with the skills and knowledge for their future professions. US Bureau of Labor Statistics reported that "more than 50% of today's jobs require some degree of technology skills, and experts say that percentage will increase to 77% in the next decade" and "Employment of computer and information technology occupations is projected to grow 13 percent from 2016 to 2026, faster than the average for all occupations"[5]. Through hands-on AI projects, TSU students have been equipped with the research knowledge and problem-solving skills to be competitive in the job market.

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