High-Performance Computing (HPC) with Design Spine Enhancement in Education Builds a Skillset for Innovation and Entrepreneurship – A Mixed Method Study

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ABSTRACT

Education and training in High-Performance Computing (HPC) and the Design Spine structure is an inclusive tool to instruct students, faculty, and staff in university courses, online material, and workshops.

HPC Enables institutions to integrate new data and increase efficiency. Design Spine allows institutions to design courses and create new modified courses. HPC is now used in academics to support both academic and administrative divisions. For example, it can be used in many phases of Education. Planning, curriculums, management related to enrollment, tuition-prepared worksheets, schedules, files, customer care programs, and hardware can all benefit from HPC. The Design Spine system can be used to design courses and create new and updated existing curricula. Simultaneously, it can combine several academic disciplines or professional specializations to create a project with Design Spine to help students with advanced experience in Business Administration and Information Technology (I.T.) Management. With the combined Design Spine and HPC, a Design Spine curriculum will lend itself to the HPC criteria since the industry's talents are the exact requirements in a Design Spine system. For example, working on a problem from start to finish involves creativity, problem-solving, critical thinking, prioritizing social responsibility, utilizing communications, and learning to organize and process project management skills. When the students learn with this method, their Education and thoughts are much less disjointed and can be more cohesive. They can better connect to their learning from all walks of life. The subjects are no longer separate in their mind but flow together quickly to solve a problem from the top down.

Keywords: High-Performance Computing (HPC), Design Spine, Project-Based Learning (PBL)

INTRODUCTION

For clarity, HPC is a comprehensive field that combines parallel computing and systems administration. It can include system architecture, algorithms, programming languages, and other aspects of the computer field to deliver higher performance than a student would get from a single workstation or desktop. HPC systems combine clusters and grids. Clusters are a set of computers or servers utilizing a group of computers like a local area network. The computers can work alone or together to perform a task. Networking with HCP saves money and allows for greater computing power. Grids are geographically dispersed but provide the opportunity to work on massive computations.

The Design Spine curriculum is Project-Based Learning (PBL). PBL is an educational path to lay the groundwork for student learning with hands-on interaction in Education. The benefits of PBL have amplified interaction in the lessons, featuring active team study and self-study, augmented communication that addresses increased student engagement with a comprehensive set of education styles and promotes critical and creative reasoning. PBL also promotes advancement in practical teamwork skills, project management, communications, ethics, and engineering economics (Brown & Brown, 1989; Hadim & Esche, 2002). A traditional lecture-based teaching approach addresses minimal learning styles. The projects within PBL provide the students with a broader background of the knowledge given in the lectures rather than formal lecture-style assignments. With Design Spine, learners are encouraged to be responsible for their learning, shift from passive to more active learning patterns, improve knowledge retention, and integrate material from different courses (Felder, 2001; Rosati, 1995; Woods et al., 2005). It usually encompasses a narrow subject area.

The connection between HPC and a Design Spine curriculum is that HPC allows educators more access to designing projects that will be industry-worthy and up-to-date when students enter the work field. Design Spine is a curriculum like PBL. PBL incorporates multiple categories, from start to finish, of a student project in a particular class. Traditionally, it would only be limited to science or engineering classes. A Design Spine curriculum is more encompassing. It provides an entire curriculum based on project learning. It is a system where the whole curriculum is project-learning based. Subjects can overlap, forcing students to make connections to areas in subjects that previously were not attained.

Changes in the world's ability to handle unforeseen changes in social and economic arenas can also cause a crisis in the educational world. The COVID crisis is an issue that profoundly impacted Education at all levels. Compulsory online and virtual teaching provided an urgent alternative to in-person classes. Reliance on the internet, face-to-face communications, teaching technologies, and methods requires creating new and updated curricula. There is a need to develop persistence in response to crises. Design Spine and HPC techniques will ensure institutions build agility and resilience when unexpected events or crises interrupt educational services. HPC can be essential in enhancing student learning and knowledge, not only regularly but also during crises. Design Spine allows institutions to design courses and create new modified courses to meet emergency needs.

Design Spine is an all-encompassing project management experience for students. The courses are directed toward project management. Project-oriented classes encourage self-responsibility for problem-solving and critical thinking, focusing on traditional engineering skills will develop qualities including organization, communication, creativity, leadership, commitment, and work ethic. Teamwork and examples on real-world projects promote self-confidence and social responsibility. The projects promoting a Design Spine curriculum can be implemented throughout college years, but hands-on PBL can also be implemented at middle and high school levels. HPC enables institutions to embody new data, networks, and storage on a grand scale to administer the foundation for students to work on studies outside the lecture room. HPC denotes simultaneous operations or parallel processing but can be on a larger scale. It achieves goals by aggregating problems to provide more computing power to solve problems quickly and efficiently. Computer technology develops exponentially. HPC is terminology for systems that use extensive computing resources. HPC is now being transferred to virtualization to maximize management and resource allocation. This research aims to contribute to innovation in Business schools by combining Design Spine and HPC technologies (Lulay et al., 2015).

ISSUES AND BACKGROUND (GOALS AND OBJECTIVES OF THE STUDY)

When HPC and Design Spine integration involves surveys for courses and the management department, any issue in the system or performance can be labeled as an element of design education. Curriculum revision may result in development involving defining learning principles, objectives, and proficiency based on the target and articulating these into curriculums**.** HPC and Design Spine can be personalized to meet the organization's needs based on requirements. An organization can select various methods to design a variety of systems.

With today's requirements, it is necessary to be able to process real-time data, live stream, chat, track projects, grades, tuition, schedules, and other functions. Processing needs to be lightning fast, store and recover vast amounts of data to meet criteria, and stay ahead of the competition. For example, If HPC and Design Spine integration involves surveys for courses. Any issue in the system or performance can be approached as a lesson in design education. The curriculum revision may conclude in building a project that involves the development of a program defining educational goals, objectives, and competencies based on requirements and integrating these into the curriculum**.**

A similar project software enterprise of the early 80s called Project Spine was created for software engineering curricula. It is a pedagogical model to advance a student's expertise from understanding to comprehension to applied knowledge by co-locating preparation, where servers are hosted at a data center. It included discussion, practice, reflection, and learning activities in time (Gary et al., 2013). 'It focused on the importance of applied learning experiences instead of content coverage. Project Spine integrates technical competencies by assigning projects in addition to the technical material covered in the regular computing courses. Experiential learning theory (Kolb, 1984) and the idea of expert functioning (Scardamalia & Bereiter, 1981) support the back-and-forth movement characteristic of learning. It allowed students to share thoughts and explanations with a partner while listening to their partner's explanation and checking it for accuracy. The focus was on experiencing learning. To develop design expertise, Adams et al. (2003) draw on the theory of expert functioning to emphasize how students should engage in 'repetitive cycles between the general and the particular.' Given the dynamic world of computers, increasing demands require practical application; therefore, Education requires providing internet and communication technologies information to improve students' knowledge.

HPC is a pathway to integrate new data into design courses and provide updated curricula. HPC can be used in academic areas because it supports the management of educational institutions in areas of their curriculum. Simultaneously, the Design Spine is a core educational design module focusing on different academic disciplines. It specializes in creativity in problem-solving, critical thinking, and learning optimization of organizational communication.

Many educational institutes have implemented business management. However, more research needs to be conducted. The impact of HPC networks on business students' professional development and management skills needs to be measured.

Because technology is changing exponentially, the methods of learning and Education must also evolve with ever-evolving business models. Worldwide, new curriculums are being developed, tested, and revised for each field to meet the requirements of changing business models. To correlate business education with the business and technology world, business education must also be updated according to modern-day business needs. Therefore, Design Spine and HPC can improve business education. The Design Spine methodology can provide the necessary gaps to enhance the curriculum. Similarly, HPC can provide the power and data storage needed to speed up the process of planning, curriculum designs, and managing administrative activities to improve student learning.

LITERATURE REVIEW

This literature review aims to enable the reader to understand that PBL has been successfully used in Education for many years. PBL focuses on real-world instances, and active learning develops student skills, understanding, and capabilities beyond traditional lecture education. PBL is the foundation for a Design Spine structure.

PBL promotes a profound understanding of the subject while developing students' higher-order thinking (Ertmer & Simons, 2018). PBL includes pupil autonomy, active learning, team partnering, credible active assignments, reflection, and transference (Grant & J.R. Hill, 2007). With projects and PBL, pupils learn through planning and constructing real-time answers to real-life problems (Cornell University Center, 2020). Project and PBL are ideal instructional models for employing analytical thought, reporting, alliance, and developing original ideas – besides 'teaching for transfer' and classes set up in real-world circumstances (Scott, 2015).
PBL promotes active and deep learning by collaboratively involving students in investigating real-world issues. A first-year course was developed by Roedel et al. that combines and integrates material from introductory courses in calculus, physics, English composition, and engineering, whereby engineering projects were used to teach design and modeling principles (Roedel. et al., 1995).

Traditionally, PBL has been implemented in engineering and computer science courses. It can be implemented in academics across the board. A materials science course implemented a project-based approach to teaching experiment design (Genalo, 1999). Students accomplished the objectives using Design of Experiments (DOE). Experiments were restrained through control variables, and self-checks for improving performance consisted of statistical measurements and other criteria. Student surveys revealed that students felt it was a valuable experience and were better prepared for interviews.

One engineering mechanics class focusing on a semester project included building the assigned product (Haik, 1999). A format focused on the project was adopted in a hydraulics class and executed as a just-in-time teaching style, keeping pupils intent on motive and the reason they were learning a specific case (McCreanor, 2001). An assessment of input using PBL in preliminary classes and a comprehensive background was investigated (Dym et al., 2005). Another study evaluated PBL by comparing engineering and other education fields (Perrenet et al., 2000). A study suggested including innovative pieces in the engineering education program to augment analytical skills in pupils (Orbun et al., 2013). Preceding educational investigation supports the inclusion of PBL if it strengthens established classes. The students are provided with more engaged and direct interactivity in the laboratory than in a traditional classroom (Sakulkueakulsuk et al., 2018).

Research also details the rewards of the PBL to be students describing problems with increased capability, improvements in clear reasoning using more explicit arguments, better Design of intricate projects, more incentive to work, improved attitude surrounding their Education, and following through with good work ethics. Active learning strategies can include group work, presentations, discussions, and question sessions (Tabrizi et al., 2017). Active learning promotes distinct pedagogies such as problem, analysis, questioning, activity, and case-based schooling. Active learning methods promote learning for all students (Attaneo, 2017) and effectively make classrooms more inclusive (Haak et al., 2011). PBL promotes collaborative learning among the students enrolled in the class. Researchers have reviewed collaborative learning as a pedagogy to facilitate learning, and the outcome indicates that students, through group learning, take part in higher-order reasoning such as overseeing, leading, analyzing, solving problems, and using creativity to invent (Scott, 2015 Fakomogbon et al., 2017). Cooperative schooling initiates goal-oriented behaviors, improved educational results, and collaborative learning (Fakomogbon & Bolaji, 2017; Mariescu-Istodor et al., 2019). PBL has improved student retention in an engineering technology program (Wood & Craft, 2000). Clark et al. (1998) show the plan, execution, and assessment of a project-based course of study within a chemical engineering class. It talks about the problems related to a regular curriculum. The new and modified program of study has an extended design course progression where each term contains a design course forming a design spine (Sheppard et al., 1999).

The Design Spine enhances studies because every design course is tied to an instructive course taught simultaneously. A notable element of the undergraduate curricula in engineering is the application of PBL. The advantages of PBL are improved pupil engagement in student schooling (beyond note taking and listening), enhanced speaking and reporting skills, reworking the pedagogics to a broader set of preferences in learning, and advancement of critical thinking and proactive reactions. A study explains the approach to developing a "design spine" within the mechanical engineering school of study (Lulay et al., 2015). Engineering design arrives at system components or processes to meet expectations. It is a sometimes-iterative system where science, math, and engineering courses are applied so resources optimally meet these stated needs.

The Design Spine curriculum can embody elements to develop critical proficiency in finding solutions, exchanging ideas, project management, ideals, engineering analysis, development of teams, and energy flow of systems throughout the sequence. The study (Frank et al., 2011) discusses the result of a four-year Engineering Design and Practice Sequence of project-based courses. Further, it discusses the sequence creation process, the course objectives and delivery for each program year, and the proposed assessment and evaluation methods. Studies investigated the role of a technology-enhanced learning perspective in teaching and using technology in learning activities (Ertmer et al., 2010; Schweighofer et al., 2018).
Using technology in the Design of learning activities can promote supercomputer technologies throughout the curriculum (Voevodin et al., 2015). HPC and functional computational skills

enrich using technology in the learning process. Technology enables the students to experience the challenge of "writing meaningful simulations" without access to HPC devices. Technology lets the students understand HPC simulations that can be replicated on a big scale (Hilpert et al., 2015). Supercomputing has become a strategic tool, and the relevance and importance of supercomputing education are increasing (IDC, 2015); Zvacek S et al., 2015; Voevodin, 2016). Student-centered methods of studying have encouraged educators to integrate skills into their teaching. Considering teachers as facilitators, incorporating technology into their teaching is critical (Catma et al., 2016). It is necessary to understand how implementing technology could improve teachers' perceived competence and use in teaching (Lemon & Garvis, 2016). Recent research to determine the possibilities of using technology in higher Education highlighted the increased favorable circumstances for professional competency development (Zagrebina et al., 2015).

METHODOLOGICAL FRAMEWORK

The methodological approach in this study is to examine the integration of HPC and Design Spine into an efficient working model for all stakeholders. This example focuses on enriching business students' learning in higher education institutions and involves administration, instructional designers, faculty, and students. That integration could include improving students' learning in higher education institutions. The researcher conducted a literature review while proposing this topic for future research. The literature review revealed a significant research gap regarding the impact of HPC and design spine on the business management skills of faculty and students even though educational institutes in the business schools were rapidly implementing those networks.

Modern technologies and scientific areas' computing scale and complexity make HPC progressively important. Performance variability, a fundamental factor in researching HPC systems, has been acknowledged for an extended period (Giampapa et al., 2010; Akkan et al., 2012; Cameron et al., 2019). High-performance anomalies in HPC systems can result in ambiguous performance and be expensive. Therefore, managing variation is critical for systems to perform optimally. A supporting structure for HPC variability control has three steps (Cameron et al., 2019). These include gathering observations and measurements on variability for specific system configurations, creating a similarity model to make indicators for new structures, and using the observations to correct future designs.

Computer engineers utilize Grid-Based Designs (GBDs) to collect data under numerous possible system configurations when the number of factors is relatively small (Cameron et al., 2019; Xu et al., 2020). HPC addresses the challenges and conditions of systems. Consequently, a lot of information is addressed, including problems with algorithms and support platforms, since pupils need competencies in these environments. (Shamsi et al., 2015). Zarza et al. (2012) highlight that HPC is valuable to Society. HPC opens the door to the evolution of many specialized programs and services. Since computers are widely used in many areas, parallel architecture is essential in academic computer science and engineering programs. HPC's parallel programming is crucial to prevalent technologies since many architectures are distinctly different.

CREATION OF AN EFFICIENT LEARNING ENVIRONMENT

Teaching parallel programming undergraduate and graduate courses is common. The curriculum suggested by the Association of Computing Machinery (ACM) in 2001 proposed a method on HPC (ROBERTS et al., 1999) and (Carley et al., 2013), and the 2008 interim revision contains a study on Parallel Computation (CASSEL et al., 2008) apud (Carley et al., 2013). 2013 A dated review addressed the educational aspects (Curricula; Society, 2013). Given its significance, parallel programming should be required as part of the computer curriculum as primary familiarity and knowledge rather than offered as an elective course (Li et al., 2008). Marowka (2008) mentions how "parallel" as a prefix applies to any current computing area due to the exponential acceleration of computing at that time. Teaching parallel programming has barriers, both in theory and practice. Theoretically determining if competence in an area is required. Choosing the lab setup and applications required to complete the assignments is also necessary. Kim, Jiang, and Rajput (2016) point out the relevance of equipment in the teaching/learning process. Hands-on learning is essential to learning parallel programming, and students need to practice and master concepts. Including parallel programming in the program challenges educators and students; most colleges lack the infrastructure for the course. Baldwin et al. (2016) explain that teachers need definite resources for HPC classes for students to compete for industry and research jobs.

MONITORING OF LEARNING OUTCOMES

Curricula and Society (2013, 33) cite "... students to spend a significant amount of additional time outside of class developing facility with the material presented in class," stressing the importance of providing methods for pupils to learn using resources outside the classroom. Required infrastructures were expensive and rarely available in computer science undergraduate courses worldwide. However, resources can be utilized remotely by dividing the power and providing a shared infrastructure, which also means sharing expenses, access problems, user issues, and bandwidth (Li et al., 2008). The invention of multicore processors accents teaching parallel programming of MIMD machines (Flynn, 2011) with shared memory (OpenMP (Dagum; Menon, 1998)) and ev distributed memory (Clarke et al., 1994). With multicore machines' availability, teaching parallel programming is again limited. Practical application for students on clusters of computers or heterogeneous platforms, including GPUs or accelerators, is still unavailable. (Wolfer, 2015). Assorted hardware is required for each component of the system. In addition, applications must be configured correctly. It is an expensive task to maintain specific skills (Baldwin et al., 2016).

MODIFICATION IN THE LEARNING ENVIRONMENT

Most work converges on using clusters and complex infrastructures. That makes the systems obtainable to students. The teacher must create an account for a student in a cluster, and the student receives the parameters to connect. Some systems still try to forward a process to grant access. That allows students to input the code via a web interface. Using clusters, upon execution, the student has to wait for the result, thus making an online/remote class not worth it. This happens in the case of SAUCE (Hundt et al., 2017) and (Foley et al., 2017), a modern web system in the literature that uses clusters for their whole system. Pupils send their code and have to wait for the process to return. It can take too long. So, the challenge regarding parallel programming in Education is to create up-to-date platforms that work in real-time while utilizing available labs at a low cost. Carley et al. (2013) address a demand for teachers to find a structure working within a cluster inside the classroom. The orders of this challenge are cost, computer availability, and performance. Jiang and Song (2015) stress issues when sharing computers with other courses and disciplines present. Additional programs use too much storage space and computational power when the infrastructure is shared locally. It severely limits resources needed for the parallel execution of large programs with other courses or disciplines: the coexistence of other programs that use part of the storage space and computation. Kim, Jiang, and Rajput (2016) respond that Information Technology has utilized Virtual Machines (V.M.) to teach information technology for twenty years or more. According to Pahl (2015a), this virtualization model needs upgrading. They require more disk storage and improved speed for initialization. Baldwin et al. (2016) use a tool for computational literacy. This tool is used in classrooms to teach HPC and conduct experiments.

IMPORTANCE OF HIGH-PERFORMANCE COMPUTING (HPC)

HPC for Education is primarily used in supporting research and lowering operation costs. With a design spine in Education, HPC offers consumers diverse computing arrays that fulfill computing needs in various research in Education. As a result, a significant consequence of using HPC is that institutions provide instruction and training to faculty and students in educational settings to meet HPC demands and personal academic interests. HPC dynamics entail the capacity to evaluate data and perform complex calculations at extremely high speeds. As a result, considering diverse literature reviews from scholars in HPC concerning the Design Spine for Education, educators have acknowledged the need for HPC education for all. In Figure 1 – The Flowchart process through HPC, superior computing capabilities are being enhanced to meet the diverse computing needs of various research interventions. Sequentially, the total cost of ownership is being reduced by using a distributed storage system with an optimized density design. Alternatively, through green and energy-saving capability, full support for the new generation of green HPC in Education is needed. Therefore, computing performance is related to the sequential processing of advanced applications across a cluster to attain cost-efficiency, optimal performance, reliability, and infrastructure designed to sustain the maximum workload.

The application and workload performance element can be achieved using end-to-end HPC workflow performance through scalable servers and storage networks. As a result, HPC platforms have impacted scientific research capabilities and education curricula in educational communities globally. Therefore, HPC in the global innovation, digital, and educational space remains a work in progress in the educational experiment. The objective is to enhance reliable, scalable, and functional Design Spine for Education globally.

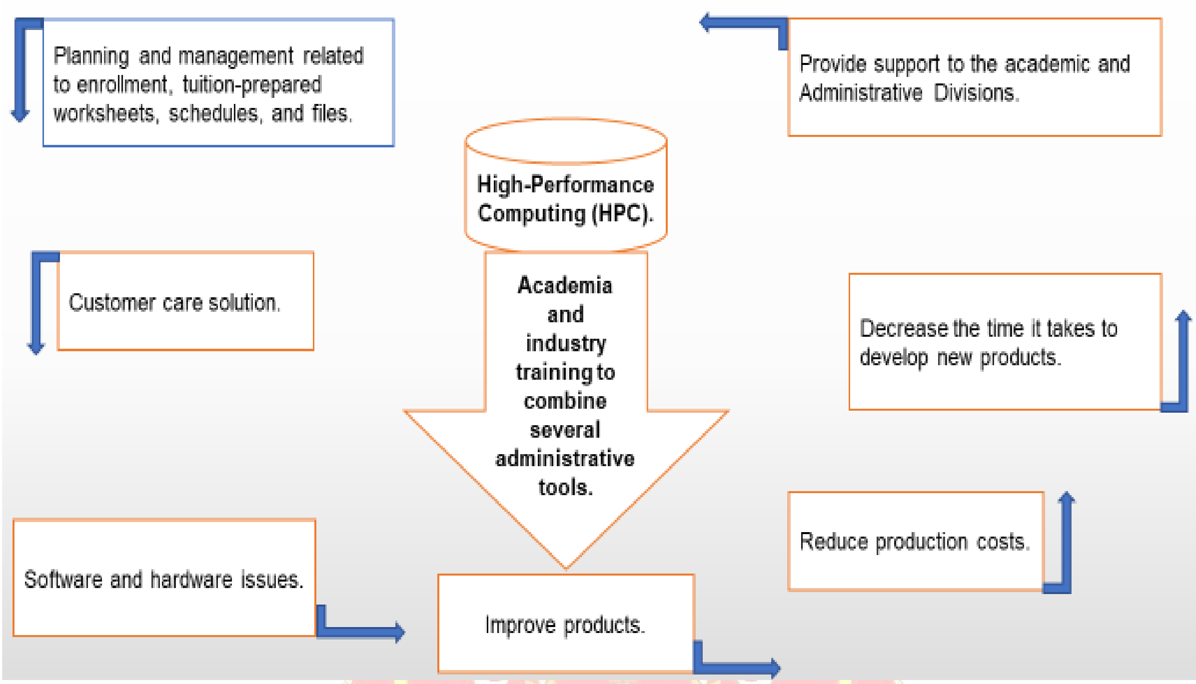

Figure 1 – Flowchart of the High-Performance Computing (HPC) process

IMPORTANCE OF DESIGN SPINE

In Figure 2 – The Flowchart process through the Design Spine is a multidisciplinary experience that focuses on communication, organization, critical thinking, and creativity, which helps students get equipped with many professional skills that could develop an entrepreneurial mindset in high demand in the professional world. The Design Spine is a multidisciplinary experience that focuses on communication, organization, critical thinking, and creativity, which helps students get equipped with many professional skills that could develop an entrepreneurial mindset in high demand in the professional world. Changes are not limited to alterations to existing courses, entirely revamping and replacing current courses, and integrating real hands-on projects across courses. Upgrading will also include more transparent communication with the students to appreciate better how individuals create new and update existing curricula, which will help them learn design processes, develop, and grow. Table 1 provides examples of how design spine can add to the student's learning process in a very creative way.

Figure 2 explains how to use Education and training to combine several academic disciplines or professional specializations in an approach:

- Creativity: the process of making an idea one's own.
- Problem-solving: the process of finding solutions.
- Critical thinking: actively applying, analyzing, and re-evaluating information to reach an answer or conclusion.
- Social responsibility: taking responsibility for behaviors/Making responsible personal choices.
- Communication: the imparting or exchanging of information.

- Organization: support of both individual and group work
- Project management: application of processes and techniques to achieve the objectives of the project requirements.

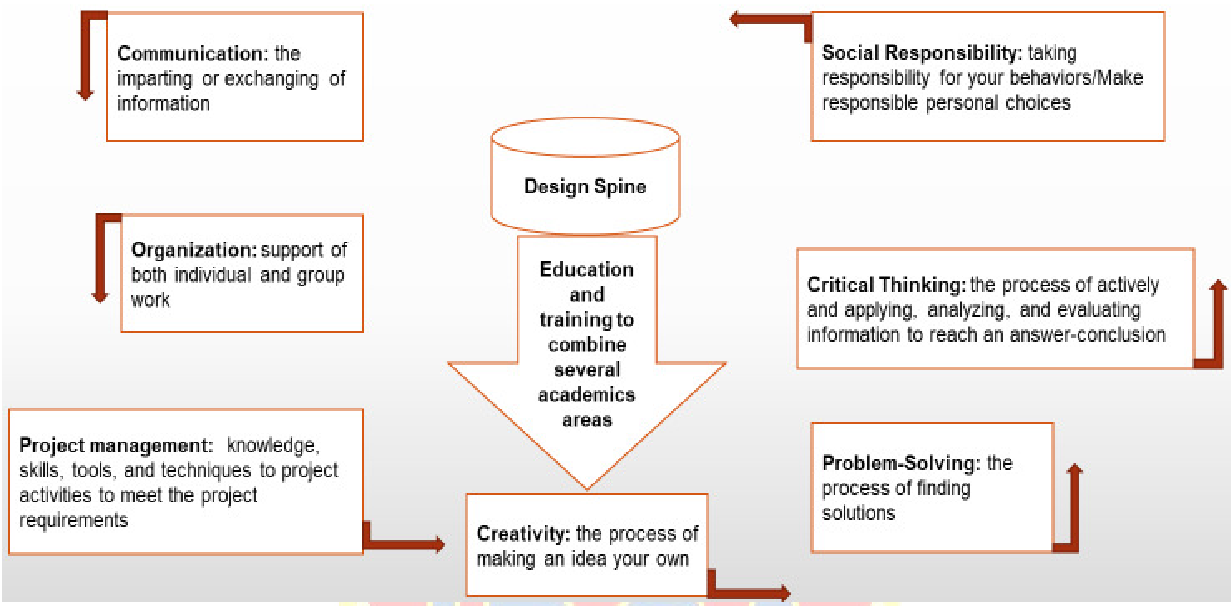

Figure 2 – Flowchart of the Design Process

COMBINING HIGH-PERFORMANCE COMPUTING (HPC) AND DESIGN SPINE EDUCATION STRUCTURE ENHANCES BUSINESS EDUCATION

Figure 3 presents the hierarchical structure of learning content. HPC provides essential opportunities for the education field to provide better services, value, and learning experiences to its students. Educational institutions can use technology to gain critical business insights and patterns to facilitate faster access to big data, storage, and analytics. Moreover, HPC has been crucial in academic research and industrial innovation for decades. HPC assists researchers, businesses, engineers, data scientists, designers, and other researchers in solving significant, complex problems and issues in less time and with less cost than traditional computing. Table 2 provides an example of the Design Spine curriculum within the context of an HPC.
Table 3 provides a possible benefit to students, faculty, and institutions from the combined Design Spine and HPC Curriculum.

Furthermore, the Design Spine curriculum provides a unique framework to equip students with technical and professional skills and an entrepreneurial mindset, which is in high demand nowadays. Design Spine incorporates real-life projects from industry to become second nature in the pupils' studies, preparing them for brainstorming and innovation in industry (See Table 1-3). Design Spine allows institutions to design up-to-date, relevant courses and create new modified courses. Design Spine benefits education by attracting more students to highly valued fields. Both combine academic content with advanced collaboration, communication, and critical thinking skills through rigorous, real-world class projects. Combining This builds students' strong knowledge of the subject and ultimately strengthens their Education.

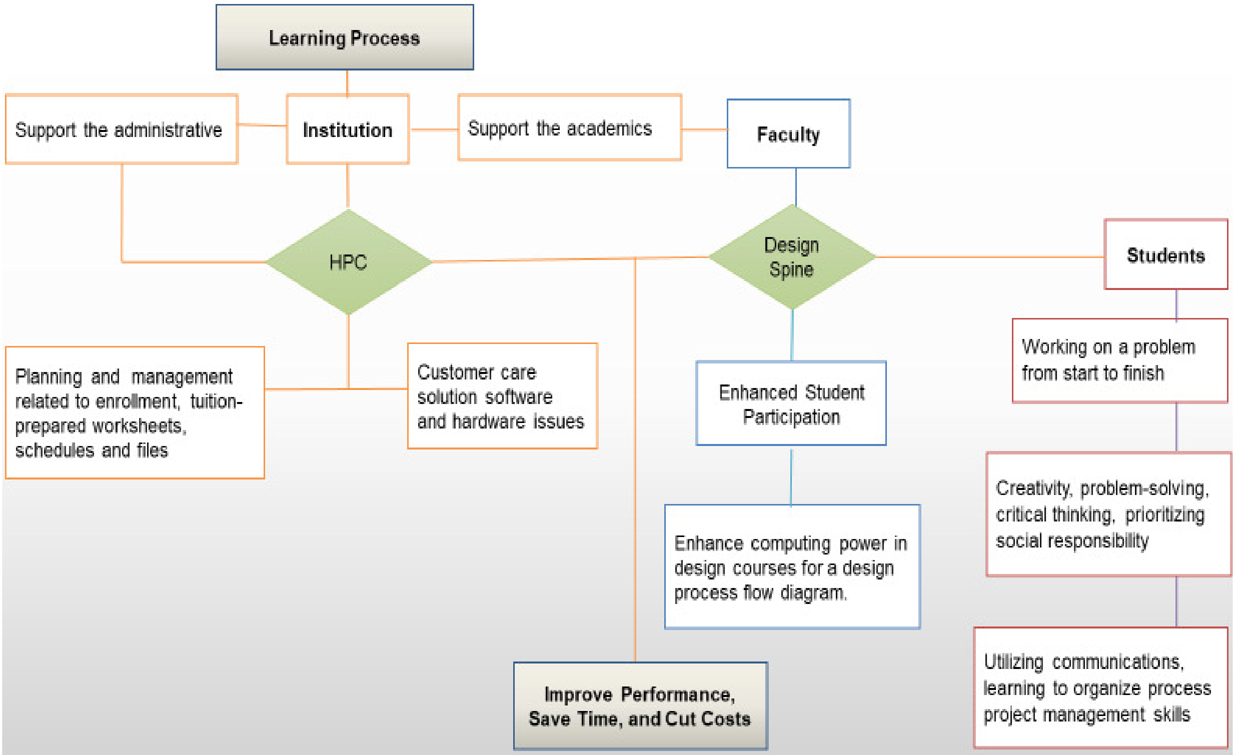

Figure 3 – The hierarchical structure of learning content

CONCLUSION

PBL in teaching at institutions has benefited all the engaged stakeholders. Applying Design Spine and HPC in a teaching pedagogy has taken the learning process a step further, providing students with the abilities to be critical thinkers, self-learners, good communicators, and entrepreneurs. Students can benefit from using online and internet resources effectively. This study proposed that integrating the two applications, Design Spine and HPC, can be more effective in a student's learning process than just adopting one pedagogy alone. Design Spine and HPC can determine students' personalized needs along with administrative, educator, and institutional requirements and process that data quickly, adapting for progress and preferences. The HPC community uses web content and workshops to allow practitioners to harness the power of distributed and parallel computing. HPC will enable the creation of advanced simulations, virtual labs, and real-life problems, and Design Spine can then integrate those simulated learning experiences into the curriculum. By merging Design Spine and HPC, students can gain a broader perspective on problem-solving and innovation because they have more power at their fingertips. Then, they can continually refine solutions and strategies mirroring real-life situations. Students experience personal growth and self-awareness as they reflect on their experiences, which builds self-confidence in preparation to enter the workforce. Combining Design Spine and HPC creates a robust framework for administrators, educators, and institutions for efficient management and students' preparedness as they begin their professional journey.

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APPENDIX

Table 1. Design Spine Curriculum

Design Spine: Design Spine allows institutions to design courses and/or create new modified courses. Design Spine is a unique multidisciplinary experience that focuses on:		
	Project Type Definition	**Tool for Implementation**
Creativity	**Preparing a project plan:** uniquely designed visual deliverables that require multiple drafts and reviews to finalize and approve **Class discussions** should be scheduled periodically to gauge student progress and determine learning. **Provide opportunities:** Reflection of objectives to determine if they are being met with the project. Students can write reflection papers and keep journals and notes on progress, listing questions or problems they encounter.	**Charts and graphs designed:**
Problem-solving		
	The Independents: These students look at a problem and solve it independently. **The Thinkers:** These students think critically about any situation before moving. **The Askers:** These students ask someone for the answer to providing that they are solving the problem now	**What, When & How:** In class/Online Discussion Groups, students are teamed in groups (i.e., using a chatroom) to take sides in discussions related to the course concepts.
Critical thinking		
	Analysis of thinking: focusing on the parts or structures of thought. **Evaluation of thinking:** focusing on the quality. **Improvement of thinking:** using what one has learned.	**Group Term Paper Project:** Where students are assigned topics that improve their critical thinking and reflection.
Social responsibility	**Pedagogy practices:** among the student groups in their interest in socially responsible business practices and the curriculum's importance of environmental issues and topics. **Identify:** The students are interested in collaborating by using different resources.	**The objective of assisting students in their studies:** Service-Learning Pedagogy, where students are assigned to develop projects to solve

		community problems.

Communication		
	Improve behavior and attitude: consists of verbal and non-verbal communication, spoken or written on whiteboards, and includes Media helps to explain complex ideas. Use it to enhance, not distract, student messages in the community with links to resources.	**Web/Media Assignments:** Outcomes can help drive better academic results where students are directed to search the internet and find articles and data.
Organization		
	Mission and objectives: to lead the art of motivating individuals or groups of students to act toward achieving a common goal.	**Plan:** Revising proposed plans, adding more specific detail, and addressing additional research design issues as one progresses. **Good progress:** Course performance occurs as the implementation process for the revised curriculum is evaluated.
Project management	**Engagement:** Concepts of project management can be implemented, including work Breakdown. Charts can be used in design and case studies. **Define the problem: By** establishing objectives and criteria and developing a plan. **Evaluate** alternatives and knowledge to select the best option. **Details:** Define and refine the details courses with practical, hands-on experience and collaboration on real-world projects from sophomore year through senior year.	**Use software:** use of project management software and spreadsheet software. Experiments and computer-based programs Ans instruments for data collection, analysis, and control with software integrating other designs and courses.

Table 2. HPC Organization Design Elements

HPC: Enables institutions to integrate new data and increase model resolution.		
	Project Type Definition	**Tool for Implementation**
Integrating	**Data:** It helps integrate existing or new data and is used to design courses. **Curricula:** Existing curricula or create new and updated curricula.	**Computer base:** Students off-campus have the same access to research but little access to librarians. A solution may be to enroll a librarian in the course via the management software (Blackboard).
Improve	**Adapt:** Education and training are to improve and adapt existing or new products to provide instruction and training to reduce costs.	**Applications:** Provide links to tutorials and free software for research and completing coursework. Encourage creating video presentations. Students can access electronic equipment from their local library.
Support	**Academics:** Academics to support the academic and administrative divisions.	**Registration:** Planning and management related to enrollment, tuition-prepared worksheets, schedules, files, customer care solution software, and hardware issues.
Model resolution	**Plan:** Revising curriculum and program	**Faculty:** Curriculums, syllabus, Student Learning Objective (SLO), and rubric.
Cooperation	**Participation:** Can send questions electronically before the presentation for teams to answer or post questions for teams to a discussion board after viewing the presentation. Student peer assessment: Students should assess the performance of their peers periodically during the semester.	**Asynchronous:** Group work assignments should be due at various points in the asynchronous environment, and it is essential to create due dates for particular milestones in the project.
Cloud	**Challenges and conditions:** The professor should assign teams. Students will communicate individual proposals of each team member and confer to select the online project they want.	**Platform:** Address large amounts of information, including computational problems and understanding supported platforms. Provide students with skills and abilities to function in these environments.

	The professor can assess their choice and provide feedback to meet course objectives.	
Communication	**Conversation:** Students create input for discussion boards to reflect on their learning regularly and respond to other student issues from the project and how They incorporated course or program learning objectives in posts. These are posted to a cloud storage area (i.e., Dropbox) for grading. Additionally, reflection journals about the process can be kept and talked about in lectures. All should provide feedback.	Through rigorous, world-class projects, communication, and critical thinking skills build strong knowledge and ultimately improve Education. Skills through rigorous, real-world class projects. This builds strong knowledge of the students and ultimately helps the Education and improves students' learning.

Table 3. Combine the Benefits of Design Spine& HPC Curriculum

Benefits	**Design Spine**	**HPC**	**Integrated HPC & Design Spine**
Institution	The benefits of PBL include better student participation in the learning process, better communication skills, adapting education objectives to a broader set of learning styles, and enhancing critical and proactive thinking.	Support the academic and administrative Divisions: Planning, management related to enrollment, tuition prepared worksheets, schedules, files. Customer care solution software and hardware issues.	Utilize the technology to gain critical business insights and comprehend the patterns to facilitate faster access to big data and analytics, improve performance, and cut costs.
Students	Working on a problem from start to finish using creativity, problem-solving, critical thinking, prioritizing social responsibility, utilizing communications, and learning to organize process project management skills.	Problem-based learning encourages a better understanding of the subject while developing students' higher-order thinking skills.	Improve learning processes and outcomes. The subject is no longer separate in their mind but flows together easily to solve a problem from the top down.
Faculty	Multidisciplinary experience focusing on communication, organization, critical thinking, and creativity helps students get equipped with many professional skills that could develop an entrepreneurial mindset, which is in high demand in the professional industry.	Integrated HPC to computing, network, and storage, each component in this cluster coordinates with the others to enhance computing power in design courses for a design process flow diagram.	Use in Education and training to combine several academic disciplines or professional specializations.