IAA Journal of Arts and Humanities 12(1):29-36, 2025. ©IAAJOURNALS https://doi.org/10.59298/IAAJAH/2025/1212936 www.iaajournals.org ISSN: 2636-7297 IAAJAH121

Best Practices for Encouraging Student Innovation

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ABSTRACT

In an era where creativity and innovation are essential skills for navigating complex global challenges, fostering student innovation has become a key focus in higher education. This paper examines best practices for nurturing innovation among students through holistic, interdisciplinary approaches. It begins with an overview of what constitutes innovation in educational contexts, emphasizing the distinction between innovation and innovations. The study then examines the crucial role of educators, supportive learning environments, and the strategic incorporation of digital technologies. Project-Based Learning (PBL), mentorship, teamwork, and risk-taking are identified as essential pillars of an innovation-friendly academic culture. A novel method proposed in this study includes organizing innovation tournaments to motivate design thinking and hands-on problem-solving. Findings underscore that creativity is not only teachable but also sustainable when supported by constructive feedback, inclusive environments, and a culture that values experimentation. Ultimately, this paper offers a comprehensive framework for institutions and educators to promote innovation in diverse academic settings.

Keywords: Student Innovation; Creative Thinking; Project-Based Learning; Innovation Tournament; Education Technology; Mentorship; Collaboration.

INTRODUCTION

Within the past few years, academic institutions have become increasingly aware of the importance of innovation and innovative thinking in education. The question primarily addressed by this study is, "What is innovation?" Recognizing that evaluative assessment of innovation is a complex endeavor, concerned mainly with innovation in the context of student design projects, the study is further focused on determining the range of dimensions relevant to understanding and measuring innovation. Creativity and innovative thinking are widely considered to be extremely important traits for engineering students entering the workforce. However, apart from limited exercises, such skills are not easily taught via traditional classroom techniques. Instead, like most abilities, they are learned via practice and experience. Consequently, the need for universities to assess innovation, as part of the whole product design course, has become all the more pressing. While brainstorming exercises, management-related courses on innovation and design, and efforts to adopt "design thinking" have proliferated in the engineering education landscape, this study proposed the development of an innovation tournament. By organizing it as an event similar to a design competition or hackathon, it provides students with the opportunity and motivation to conduct innovation-oriented design and development work. To implement a successful tournament, it must be customized to fit each discipline and institution's unique context and talents. This study focused on understanding design innovation, what it is at a deeper level in the context of student design projects, to generate and subsequently validate an appropriate set of analysis frameworks, performance evaluations, and evaluation rubrics. The ultimate goal is to hope that, once in place, these tools can be utilized by others who would endeavor to organize similar tournaments, holding their classes accountable to these criteria $\lceil 1, 2 \rceil$.

Understanding Innovation in Education

The concepts of "innovation" and "innovations" convey different ideas. The former is a broad term, while the latter refers to specific examples. Innovations can appear in various forms such as new products, services, processes, markets, or approaches, covering enterprises, industries, government, and education.

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Understanding these types, particularly in education, is crucial for those involved in the sector. The Education Innovations Alliance defines education innovations as "new processes, approaches, or devices" aimed at resolving long-standing issues, leading to significant changes in practice, thinking, or culture. Additionally, innovations in media and technology within education are notable. Education media refers to any communication tools used in education, while education technology involves tools that apply scientific knowledge for practical uses. This report examines education innovations alongside media and technology innovations. Globally, individuals and organizations are brainstorming ideas on educational innovations aimed at improving student learning and creativity, with a focus on making these innovations commercially viable for various stakeholders in the education ecosystem, including students, parents, teachers, and institutions. With over 1.8 billion K-12 students globally, the development of effective education innovations differ among stakeholders. Investors view them from a business standpoint, while researchers adopt a more scientific approach $\lceil 3, 4\rceil$.

The Role of Educators in Fostering Innovation

Three common shortcomings in identifying innovative practices are a narrow focus, a dislike for complexities, and neglecting the community nature. Many educational innovations use digital tools but concentrate on limited engagement tasks. Our research suggests that new conceptual tools can empower teachers and students to tackle complex problems. Digital tools extend beyond basic software to include robotics, 3D modeling, sound manipulation, collaborative archiving, digital storytelling, and simulations. Task design must present high cognitive challenges; otherwise, even sophisticated platforms may only lead to passive engagement. While common, effective problem-solving skills are rare in classrooms. Some innovations, despite having clear definitions and sample sizes, involve complex analyses that high-volume research struggles to interpret, yet they thrive in global communities of practice. Despite their straightforward appeal, honest politicians recognize the divide between normative expectations and reality. For instance, teachers often dismiss the insights of practitioners as theoretical. Many years have elapsed since well-funded educational discussions failed to shift accountability perceptions linked solely to testing. Complex realities hinder the rapid adoption of innovations. Recognizing such innovations requires understanding them as always existing within a specific community, which needs further elaboration. Previous assessments overlooked this aspect, presenting a more rigid view of innovation. A continued focus on community nature and dynamics could enhance discussions on innovative practices $\lceil 5, \rangle$ 6].

Creating a Supportive Learning Environment

Creativity is a highly valued trait among students, yet many educators believe students lack high levels of it. In recent decades, fostering creativity has become crucial as it is one of the key 21st-century skills. The development of creativity is seen as a skill, influenced by various cognitions, motivations, and environmental factors that contribute to original and useful outputs. A safe and supportive environment is essential for nurturing creativity, which has global relevance. However, inhibiting factors can stifle student voices and lead to uninspiring lessons. To address this, formative assessments that promote a culture of self-regulated learners are vital. An encouraging environment helps students view their classrooms and teachers as supportive, minimizing fear. This raises the question of how teachers can enhance creative potential within and outside the classroom. Small adjustments to lessons and positive encouragement from teachers can markedly boost creative thinking. A climate that fosters creativity starts with a classroom atmosphere of trust, respect, and encouragement. Teachers can then gradually develop safety by allowing more freedom during lessons, which in turn promotes divergent thinking among students [7, 8].

Incorporating Technology in Innovation

Software, electronics, and programming provide an ideal landscape for learning and product design. Digital technology grants students powerful tools for the investigation and manipulation of information, allowing them to formulate new ideas and products that are not limited to paper-based material. This area encompasses the use of computer-based dynamic modeling tools, such as spreadsheets and programming languages, providing students with spaces in which data can be manipulated freely and rapidly to generate new forms, insights, and products. It allows students to represent, create, and analyze designs and their prototypes in several media. Multimedia software on time-based media provides students with a framework for cultural production. The affordances of each technology favor creativity by providing a landscape in which forms are manipulable for interpretative, analytic, and constructive purposes.

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Increasingly, education is being challenged to respond to globalization and innovation-driven local and national development agendas. Access to computers and the internet has grown dramatically within recent years in many developing settings, increasing the potential landscape for accessing knowledge and the sharing of culture, beliefs, and worldviews. Information and communication technologies play a critical role in facilitating innovation, creativity, and experimentation. The introduction of cloud computing technologies is breaking new ground in education. It is establishing a landscape for interactive and constructionist learning experiences, designing scenarios where students have opportunities to explore and model students' ideas on science processes mediated by technology. The understanding of computational science, robotics, mathematics, and the field of control and algorithmic processes is integrated within a project-based learning scenario. The levels of social creativity are addressing diversity in talent, discipline, resources, and priorities in science education, where inequality is embedded in the education system [9, 10].

Project-Based Learning Approaches

Project-based learning (PBL) is a hands-on, student-centered process in which students gain knowledge and skills by investigating a central question, problem, or challenge. PBL requires students and teachers to act in new, different ways, and change can come about only through a sense of urgency and the communication of a vision. A growing body of research shows that such project-based learning (PBL) approaches can promote student achievement, motivation, and learning for understanding. Yet, projectbased learning is no easy task. Rarely has research studied the process of PBL with its complexities and challenges, and even more importantly, student views and perspectives are often absent. Thus, the present study investigated and reported on cases and examples of PBL in hopes of informing this area. Current research on project-based learning is examined in the context of a developmentally sequenced, multi-year, Grade 5-8 curriculum project called "Science, Technology and Society" (STS). Research findings are presented that address teachers' growth relative to PBL, as well as issues and concerns regarding children's learning experiences and products with PBL. The definitions of PBL are many. PBL is often viewed in graphic form as a continuum of teaching/learning processes, ranging from totally teacher-structured and controlled learning activities to opportunities for student choice and independence. However, this continuum of activities is neither linear nor fixed. Context plays an important role in implementation, and there is no single best PBL approach. Context initiates the "nature of the beast." Decisions made before/at the beginning of a PBL experience can dictate the course of that project. Changes in one or more contextual constructs can adapt the PBL process to fit the public culture of the school [11, 12].

Encouraging Creative Thinking

Many faculty members report developing innovative projects, topics, and guest speakers inspired by students. This fosters a safety net for creative endeavors, especially for those hesitant to embrace their creativity. Notably, some student innovations directly influence future course design, including bibliographies, online resources, assessments, and project opportunities for external presentations. By broadening the scope of courses beyond the standard curriculum, faculty empower students to pursue their creativity. In response, students engage with their talents, presenting a project on a chosen course-related topic over a week. The outcome culminates in a 40-minute class presentation encompassing various creative skills. Completed projects range from presentations on life drawing to software programming and movie analysis. Anticipating over 100 diverse projects, presentations vary from business-like formats to role-playing activities. To ensure impactful projects and effective use of time, students receive tools for preparation, including evaluation criteria, technical advice, questions for audience engagement, and strategies for successful delivery [13, 14].

Collaboration and Teamwork

Encouraging teamwork among students in an innovative atmosphere is both challenging and beneficial. Administering student teams requires a careful approach as they learn each other's expectations and styles. Promoting collaborative ideas can lead to friction with other groups wanting to benefit from their innovations. Faculty must safeguard this environment while fostering student engagement in the broader campus innovation community. To prepare teams, define project objectives and expectations, tighten scope, and adjust timelines as needed. Foster ownership and accountability by encouraging the submission of internal documents. Assign roles strategically while supporting each other's weaknesses, and promote transparency and respect to draw insights from diverse perspectives. Regularly communicate progress by encouraging questions throughout the creative process. Engage in brainstorming sessions with unconventional ideas, break down processes, seek external feedback, and

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regularly review progress. Accept constructive criticism, rehearse thoroughly, and delegate tasks while engaging the audience with humor, sensitivity, and confidence. Once teams are formed and expectations are set, step back and trust them to find their rhythm. Different communication and self-management styles will emerge, and while some teams may adapt quickly, others may take longer. Recognizing these growth moments requires patience, so respond only to significant issues rather than minor mistakes [15, 16].

Mentorship and Guidance

Mentoring students in innovation can take various forms and benefits from distinguishing between softer and harder outcomes. Softer outcomes include recognition in presentations, invitations to networks, or advice on funding, while harder outcomes involve grants or incorporating proposals into university plans. Typically, college faculty engage at the softer outcome level with students on innovation initiatives, which can be highly productive, particularly in the early stages of such efforts. Faculty participation usually takes on a supportive or advisory role, meaning that the responsibility for organizing initiatives mainly rests with students and non-academic staff. To help students effectively organize their initiatives, three essential lessons emerge: 'make it visible', 'create reliable networks', and 'fulfil obligations'. These principles can guide faculty mentorship in these contexts. An objective perspective can help identify opportunities for increased faculty involvement, although this should not compromise the positive outcomes. When students seek deeper faculty engagement, they must adopt a broader and more formal understanding of faculty roles than typically recognized. This expanded definition is crucial for making faculty aware of involvement opportunities. Additionally, implementing systematic changes that facilitate deeper engagement can help create lasting connections between students and faculty. These adjustments will ultimately enable student organizers to experience richer and more meaningful faculty participation than is customary, enhancing the impact of their innovation initiatives $\lceil 17, 18 \rceil$.

Encouraging Risk-Taking

Many educators feel that college students today are less creative than in the past, perceiving a hesitance to take intellectual risks. This perception may stem from a media-driven culture that encourages consumption over creation, as well as pressure regarding grades and career prospects, leading talented students to play it safe. Professors often worry they are fostering uncreativity. While encouraging students to take risks, educators fear failure themselves. Unexpected student responses to creative assignments have prompted reassessment of course structures. Simple tasks have occasionally led to unforeseen outcomes, such as an offbeat video that resembled a comedic clip rather than a meaningful analysis, highlighting diverse cultural views on creativity. Institutional requirements can dictate preferred cultural perspectives, making it challenging to inspire students to think outside the box. This pursuit involves two primary goals: to encourage educators to challenge their own biases and to inspire students to embrace risk in their creative work. Professors must model risk-taking for their students. Reflecting on the honors college courses, many educators recall their most impactful assignments, inspiring colleagues who share stories of profound learning experiences that resulted in outstanding work [19, 20].

Showcasing Student Innovation

Educational institutions have adopted various strategies to foster innovation, notably by providing platforms to showcase student work. This chapter delineates four key strategies for highlighting student innovation, complete with descriptions and practical hints for implementation. It encourages adapting these suggestions to fit unique circumstances and complex human behaviors. Examples include: one university's Showcasing Student Innovation process, where selected student groups present their innovative projects each semester; another institution hosts a three-day event featuring poster sessions, discussions, and presentations for showcasing research; an Innovation Expo at a different university displays products and prototypes, allowing attendees to see students' written documentation; lastly, the Student Innovator Showcase invites students to gather feedback on their designs for products, processes, or services aimed at enhancing lives. These strategies, while adaptable to specific contexts, have proven successful in various institutions. The chapter offers case studies for a comprehensive understanding of these examples before delving into implementation specifics. While these cases are limited, they illustrate the potential for broader applications within educational contexts [21, 22].

Partnerships with Industry

Industry partnerships should be pursued, and careful consideration should be given to what type of project can ensure that students can be creative and innovative. This approach was successfully utilized in a summer course with freshman students in a Makerbot Hands-on Workshop, learning about 3-D

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printing and developing a business idea that could involve a 3-D printer. Students formed six teams and selected three different 3D printer makers. The students were challenged to customize one of the 3-d printers to be innovative, which resulted in one team modifying a Lego-2-d printer to print a chocolate maker, another team making a large-sized printer that could build a portable speaker owned by oneself, and students made a dust-filter-equipped printer to enhance the 3D printer usage experience. All of these projects integrated gaming with developing and pitching their business ideas on how/why to buy such 3D printers. This approach enriches course content by introducing theoretical knowledge to the practical application of knowledge. Senior-level marketing students developed a communications and marketing strategy for their local Rotary Club, which is responsible for Santa Cruz County's premier blended learning charter school. Students' immediate concerns - logistics, constraints, and practical realities- gave way to innovative and creative ideas that earned applause from the client. Student strategies were so good that plans were recommended for immediate application. A collaborative project between Mechanical and Industrial Engineering departments and Tyler Junior College (TJC) in Texas was established, in which some schools across the globe have joined through the Industrial Engineering Curriculum. As a result of students studying abroad, learning about different cultures, sharing innovative ideas, and forming longlasting friendships internationally, long-term collaborative projects like these should continue to expand. TJC, Hanyang University should work to make student projects a yearly occurrence, to generate even more benefits for all involved $\lceil 23, 24 \rceil$.

Evaluating Innovation Programs

Measuring the success of a program can be a challenge. The real difficulty comes from evaluating the outcomes of an innovation program. As stated earlier, it is believed the program is worth doing if only one team benefits from the outcome. But how to know? One suggestion is to fundamentally measure the efforts invested in developing rapport among students. If rapport is achieved, the program does what it is meant to do, whether innovation comes out of it or not. Alternatively, rapport can be considered as a basis and the easiest measure of success. Innovation can be treated as the holy grail of the program, with the understanding that although it may be aspired to, it may or may not occur. It is hoped this has provided insights into what to look for and what to expect in determining whether innovation occurs as a result of a social program. If nothing else, this insight will help understand why outcomes cannot be easily captured. There are, of course, many downsides to being a social mathematician as proposed above. It runs the risk of sacrificing the enjoyment of the "show" to go to bed at night in peace. However, "hard" measures are of somewhat limited use. As with designing for conversations, most relevant conversation design efforts are conducted at the event itself. Consequently, quantitatively measuring an event's effectiveness is difficult at best, although some measures, such as output volume and attendance, can be considered. Nonetheless, a "measurement" rubric is proposed here to serve as a guideline that can be modified to suit specific needs. It can also be used as a discussion point while gathering design input. For each measure, a 1-to-5 numerical scale can be applied if necessary, with one being low, two being somewhat low, three being medium, four being somewhat high, and five being high $\lceil 25, 26 \rceil$.

Case Studies of Successful Innovation

This report examines innovation in undergraduate senior design projects, particularly through a socialimpact engineering example, to better understand course outcomes. It analyzes how GEM students exhibit innovation. Teams of students, maintained for years, foster learning among members. A new team-synthesis activity emerged from poster exercises at the GEM Pre-conference, requiring teams to create a design brief from various images. The 91 new GEM representatives preferred pre-meeting discussions with team members. Those receiving extensive instructor coaching particularly enjoyed discussing intellectual innovations. A set of design parameters aids in exploring concept designs, revealing diverse innovation expressions among students. Adjusting the course syllabus' emphasis on certain innovation types may influence their prominence in projects. Insights from these findings offer guidance for refining course delivery methods. To reduce bias in project evaluations, a structured method for classifying innovations equips managers to determine which metrics to prioritize. Specific dimensions of innovation gain more attention from managers, sometimes differing across organizations or projects. Addressing innovation triggers can diminish biases and enhance meritocracy. For student design projects, team dynamics play a crucial role in innovation. Teams are chosen to balance innovation dimensions aligned with project requirements. Managers anticipate a mean shift from baseline to innovation, indicating improvement stems from input diversity, not impatience. Implementing an innovation scorecard in the classroom will enhance students' understanding of human factors in

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innovation assessment. Core competencies within formal organizations help recruit, train, and measure desired inputs from students to firms. Teams are likelier to be innovative when recruitment is broader and screening is specific [27, 28].

Future Trends in Student Innovation

Numerous movements are evolving that are attempting to prepare the youth of today for the highly innovative and creative climate of the communication age. Young people today grow up with digital technology. Hence, there needs to be quality learning about innovation and creating the conditions for it to thrive in education. In this environment, continual reinforcement through discussion and lived experiences of what innovation is and how it can be realized is essential. Both through participation in surrounding activities and as visitors are part of such a society. Alongside these, in children igniting a passion for learning, traditionally seen as irrelevant information, should more strongly highlight the multiple learning routes and the value of one's emerging experiences to the contemporary world. The discussion of approaches, techniques, and offers of support needs to be made far more accessible. The effects on agency, community action, learning, motivation, and self-worth need to be heavily marketed. The awards for innovation centered activities need to be made more visible and sought within and across all sectors of society. Innovation as a multi-faceted area of research can be systematically assessed using multiple indicators and indicators. The generation, commercialization, and exploitation of new ideas and knowledge is a source of wealth creation and derivative benefits. Only a tiny fraction of possible new ideas are constructed into successful commercial non- and semi-manufactured products. Innovation is about creativity, and creativity needs to be nurtured at an early age through education. Involvement in innovation activities, role models, and encouragement are amongst the factors considered most important in persuading students to think about actively pursuing a career in innovation. In formal education, stimulating the creative-thinking skills of students in secondary, primary, and preschool environments is the most emphasized approach. Educators and businesses recognize that creativity is an important issue. Businesses want to employ innovative graduates, but there is a mismatch between the notion of creativity in education and business [29, 30].

CONCLUSION

Encouraging innovation in students requires a fundamental shift in educational philosophy, one that values creativity, embraces failure, and promotes exploratory learning. This paper highlighted multiple strategies to foster such a culture, including the integration of project-based learning, technology-enhanced environments, team collaboration, and mentorship. Central to these efforts is the educator's role in cultivating supportive, risk-tolerant classrooms where students are empowered to explore and experiment. Structured opportunities such as innovation tournaments offer a scalable, dynamic model to inspire real-world problem-solving and ingenuity. As institutions aim to prepare students for rapidly evolving career landscapes, embedding innovation into the core of academic practice is no longer optional but imperative. A community-focused, adaptable approach will ensure innovation thrives as both an outcome and a process in education.

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CITE AS: Kakungulu Samuel J. (2025). Best Practices for Encouraging Student Innovation. IAA Journal of Arts and Humanities 12(1):29-36. https://doi.org/10.59298/IAAJAH/2025/1212936