مركز جامعة قطر للعلماء الشباب
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Faculty and PostDoc, Social Change and Identity

Innovative tool to educate the high school students through research based learning

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ABSTRACT

The need for enhanced engagement of school students for better behavioral outcomes in line with scientific learning and acquisition of science process skills have continually incited educators to strategize innovative teaching approaches. Meanwhile, innovations and research from the scientific community has consistently been prioritized to be of higher significance, therefore, demanding highly skilled STEM labor in the global market, henceforth challenging educators to brace the next generation with high proficiency in STEM fields. The research study focuses on an out of school approach that caters to the future industrial demands in STEM workforce, henceforth acquainting the high school students with research methodology for improving their technical efficiency and intellectual capacity in problem solving and critical thinking. The study program was conducted on 208 students from public schools in Qatar, who participated in 68 research projects, each project being engaged by a group of 3 to 4 students during a period of 2 months at Qatar University research laboratories. The performance of participants were analyzed by mixed methods implementing both quantitative data based on questionnaires and qualitative data based on feedback interviews from research mentors, schoolteachers and the participant students. The results of the program yielded positive outcomes and promising feedbacks from the stakeholders as the school students gained competences exhibited by under-graduate or graduate students like research self-efficacy, research skills and aspirations for scientific careers, accomplishing the objectives of the program. This study program henceforth was successful in bridging the gap between high school and university, as the participant students had an advantage in confidence over their peers in university laboratories and technical writing assignments

INTRODUCTION

Exposing students to an environment in which they can develop self-efficacy and research skills is an effective way of equipping youth with critical skills and decision-making abilities. This approach to nurturing students with fundamental 21st-century skills or 'life skills' as used by few teachers has to start in elementary schools by subjecting them to a challenging and active learning environment. Previous studies have proven that learning in a research-based education environment can prompt students to become more independent, autonomous and critical learners, enabling them to succeed in a 'transdisciplinary world of learning', grooming them to adapt to changing employment requirements and career shifts (Jackson & Ward, 2004). Educational efforts in science, technology, engineering, and mathematics (i.e., STEM disciplines) are continuously upgraded as a part of enhancing student interest and involvement. Outreach programs focus on increasing student engagement and interest by providing educational opportunities and resources that make learning about STEM and research relevant to young learners. Typically, this is done through engaging, hands-on, authentic activities (Carlson and Sullivan, 1999). A significant pedagogical characteristic contributing to the success of outreach programs is reliance on opportunities for learners to generate ideas and act on them, followed by reflective discussions led by a knowledgeable person, a facilitator, who assists learners in noticing and explaining the scientific and engineering principles associated with the activity (Adams, Turns, and Atman, 2003; Cognition and Technology Group at Vanderbilt (CTGV), 1997; Schwartz, Brophy et al., 1999; Schwartz, Lin et al., 1999).

RESEARCH OBJECTIVE

The main goal of the present study is to acquaint students with research procedures used by scientists to develop investigative, decision-making, reasoning, and critical thinking skills, which consequently contributes to the impact of various hands-on activities on students' interest in scientific subjects. In particular, two research goals are addressed in this poster. The first focuses on incubating students in research environments to develop critical skills and self-efficacy as showcased by scientists. The second addresses the impact of this informal setting on their interest in scientific careers.

METHODOLOGY

The study methodology provides a platform for 208 students from 12th-grade in the period between 2012 and 2019, from different public schools in Qatar, to participate in a 2- month tenured research program. The 28 students work in groups of 3 or 4 to become an integral part of high end scientific research, conducted in material science disciplines like concrete, bio-degradable plastics, polymers, sensors, at Center for Advanced Materials Research Center (CAM) in Qatar University. The scientific research is accomplished through the following phases (refer Figure 1).

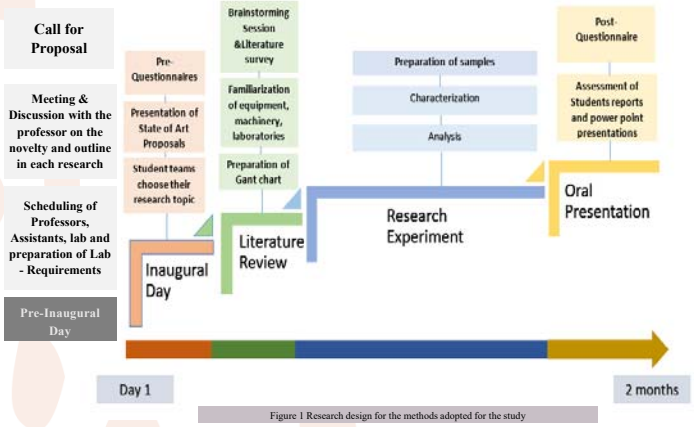

Figure 1 Research design for the methods adopted for the study

CONCLUSION

Implementing research based learning for empowering high school students by engaging them in active research projects in the country for the past consecutive years has yielded a linear rate of success. The integration of the research based approach, as one of the key strategies has encouraged the students to gain adequate scientific skills, thereby self-promoting and improving their confidence. The improvement of student intellectual capital, the creation of research products, and boosting of self-efficacy through the study approach was witnessed and confirmed by the schoolteachers, research project mentors and the participant themselves. The university students who had underwent the study program in early years confirmed on the expected advantage over their peers in overcoming their 'first year' fears and exhibiting comparatively superior technical skills and writing skills. The faculty mentors also notified the weekly progress of the participant students over the 2-month tenured research in terms of their problem identifying, understanding and solving competencies, laboratory technical skills, contributions in developing applications, confidence in approaching the research project and presentation skills. The schoolteachers who monitored the enhanced confidence in the participant students and the improvement in their peer collaboration, teamwork and communication technique also confirmed the later. These successful results were measured by different parameters like weekly progress charts, PowerPoint presentations, technical reports and the after-program performance in school and university. Motivating parameters that highlights the successful implementation of the program also includes the pre and post questionnaire analysis reports where a significant difference is observed between the two sets of data along with key indicators assessed by the mentors and schoolteachers. However, there are limitations wherein the assessment of participant students and non-participant students is not applicable as both groups are not provided impartial platforms and the school curriculum engaged by both the groups do not provide ample settings to analyze the intellectual growth of the participant students. Selected participant students also successfully presented their research projects in International competitions like ISEF and ITEX, thereby acquiring global recognitions for themselves and for the country. Therefore, the practiced approach has successfully cultivated innovative technique and research efficacy in the students, thereby creating scope for replicating the research based learning method in different domains of education.

RESULTS & DISCUSSION

The result of the objective is determined by the students' improvement in science process and designing skills, assessed through the outcomes of their research project and questionnaires, as the tool of analysis.

Cycle	Statistics			Samples test		
	Participants N	Pretest Mean (SD)	Posttest Mean (SD)	Mean Difference (SD)	t Value	p Value
3rd	36	3.78 (.573)	4.17 (.572)	.39 (.891)	2.62	0.013
4th	29	3.56 (.324)	4.39 (.550)	.83 (.596)	7.49	0.000
8th	24	2.22 (.645)	2.84 (.896)	.63 (1.216)	2.52	0.019
9th	14	3.64 (1.499)	3.79 (1.017)	.143 (1.303)	0.41	0.689
11th	16	1.83 (1.211)	3.42 (.614)	1.58 (1.124)	5.63	0.000
12th	23	1.65 (.342)	3.2 (.914)	1.55 (1.013)	7.35	0.000
14th	28	2 (.682)	3.32 (.814)	1.32 (1.055)	6.63	0.000
15th	22	1.94 (.594)	2.69 (.346)	.754 (.469)	7.55	0.000
17th	16	2.19 (.980)	3.17 (1.010)	.978 (1.295)	3.02	0.009

Table 1. Descriptive statistics (pre/post), (n = 28)

Scores were statistically higher for all questions in posttest than for those pretest, as shown in above. This means that student's scores were higher in posttest than in pretest with respectable differences between their pere-mean and post-mean.

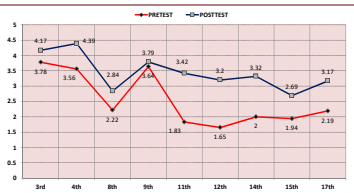

Figure 2. Weekly progress chart of different groups

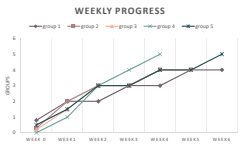

Figure 3. Study population mean (pre/post) by IAR cycles (n =208)

Feedback from professors and their research assistants was recorded as a part of the evaluation, as they regularly monitored the performance of the students during their research. Their feedback mainly attested to the growth of students from week 1 in the areas of inquiry based skills, problem assessing and solving skills, and communication skills. Over time, they also evaluated the students' performance in carrying out experiments in labs, observation of results, presentation skills, and writing technical reports.

Figure 4. Manufacturing of Ultra-High Performance Concrete

Figure 5. Fabrication Humidity Sensors Using Polymeric Materials

Figure 6. Leidenfrost effect drops as a reactor for direct methanol fuel cell catalyst

Figure 6. Energy Harvesting

Figure 7. Performance of Novel Electro less Plated Ni-P-C3N4 Nano composite Coating

The students also presented their acquired knowledge at a symposium in the presence of industry leaders, research professors, and many others. This process showcased the development of the students' presentation skills and ability to carry out scientific discussions between students and the audience that included professors and industrial leaders, reinforcing the student transformation in scientific learning and personality development. The students were also confident to answer the queries based on general context and the research topic during the symposium.

Figure 8. Students answering enquiries

REFERENCES

- Carlson, L. E., and J. F. Sullivan. (1999). Hands-on engineering: Learning by doing in the integrated teaching and learning program. International Journal of Engineering Education 15 (1): 20–31.
- Adams, R. S., J. Turns, and C. J. Atman. (2003). Educating effective engineering designers: The role of reflective practice. Design Studies 24 (3): 275–94.
- Cognition and Technology Group at Vanderbilt (CTGV). 1997. Jasper Project: Lessons in curriculum, instruction, assessment, and professional development. Mahwah, NJ: Lawrence Eurlbaum.
- Schwartz, D., S. Brophy, X. Lin, and J. Bransford. 1999a. Software for managing complex learning: Examples from an educational psychology course. Educational Technology Research and Development 47 (2): 39–59.
- Schwartz, D. L., X. Lin, S. Brophy, and J. D. Bransford. 1999b. Toward the development of flexibly adaptive instructional designs. In Instructional design theories and models, ed. C. Riegliuth. Hillsdale, NJ: Lawrence Erlbaum.
- Jackson, Norman; Ward, Rob. 2004. "A Fresh Perspective on Progress Files—A Way of Representing Complex Learning and Achievement in Higher Education." Assessment & Evaluation in Higher Education 29: 423–449. Doi: 10.1080/0260293031000689028[Taylor & Francis Online], [Google Scholar])

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