2017 HAWAII UNIVERSITY INTERNATIONAL CONFERENCES
SCIENCE, TECHNOLOGY & ENGINEERING, ARTS, MATHEMATICS & EDUCATION JUNE 8 - 10, 2017
HAWAII PRINCE HOTEL WAIKIKI, HONOLULU, HAWAII

EVALUATION OF PROJECT-BASED LEARNING PROGRAMS IN AQUACULTURE: A QUALITIVE STUDY OF HIGH SCHOOL STUDENTS' LEARNING

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Synopsis:

The purpose of this exploratory qualitative study was to identify the impact of three separate mentor-guided, project-based learning programs with foci on aquaculture as perceived by high school students.
This case study attempted to explore the experiences, perceptions, and attitudes of students and their intrinsic desire to learn more about STEM-related fields and careers when exposed to hands-on/minds-on, aquaculture projects (activities) located at Kentucky State University's Aquaculture Research Center in Frankfort, Kentucky. Students were engaged in real-world aquaculture environments such as learning how to construct, size, and troubleshoot a small-scale backyard aquaponics system, water quality management, and fish nutrition research. The data-gathering techniques included field observations, written questionnaires, journal reflections, and in-depth interviews with participants about insights learned as a result of their participation.

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Studies have shown that students engaged in authentic problem solving experiences similar to those they may encounter in real-world, out-of-school contexts often develop ownership of and interest in the project, and develop essential 21st Century Skills (e.g., problem solving, collaboration, creativity, critical thinking). Project-based learning approaches naturally incorporate authentic problem solving of local community issues that are of interest to students and adults alike. Further, such experiences task students with working collaboratively with peers to learn about the issues, develop working understanding of concepts in science, technology, engineering, and mathematics (STEM), use their knowledge to develop working solutions for issues they study, and develop valuable communication skills as they report their project ideas and findings.

Aquaculture project-based activities can provide innovative learning opportunities in STEM through relevant, real world investigations and problem solving. It has been shown that aquaculture has the potential to help improve and develop important new life skills and promote youth development.

This qualitative study examined the impact of three separate mentor-guided, project-based pre-college programs on secondary students with foci on aquaculture and were conducted at Kentucky State University's (KSU's), Aquaculture Research Center. 1) A three-week 2016 Summer Apprenticeship Program (SAP) hosted by KSU's College of Agriculture, Food Science, and Sustainable Systems that provided experiential, hands-on aquaculture research opportunities to 10 high school students (grades 11 and 12). Most were minorities and from rural and underserved communities and engaged in mentor-guided inquiry-based learning experiences. 2) One (1) high school student participated in a 14-week Professional Mentorship Program along with a KSU Undergraduate student during the Fall of 2016 semester, while two (2) high school students participated in a 14-week Professional Mentorship Program during the Spring 2017 semester. 3) Three (3) high school students

participated in an Upward Bound summer work-study program in 2016. Students in all programs were engaged in real-world authentic aquaculture learning environments integrated with technology by using scientific instruments and collecting and analyzing research data.

There is a problem of recruitment and retention at KSU. Hence, there is a strong need to strengthen collaborations with Kentucky high schools and increase the academic pipeline and awareness of KSU's agriculture STEM programs and ultimately increase student enrollment. Likewise, despite changing demographics in the United States, women and minority students remain woefully underrepresented in STEM fields. It has been stated that a more diverse student body in STEM leads to a workforce of scientists, engineers, and mathematicians who are more equipped to function effectively in today's diverse and global workforce. The authors acknowledge that significant work must be done to increase and sustain the interest of underrepresented students in STEM in the United States, since a more diverse student body in STEM fields is lacking.

The purpose of this exploratory case study was to identify the impact of mentor-guided, project-based learning programs through hands-on aquaculture activities as perceived by high school students. This study attempted to explore the experiences, perceptions, and attitudes of secondary students' and their intrinsic desire to learn more about STEM-related fields and careers when exposed to hands-on/minds-on, aquaculture projects (activities).

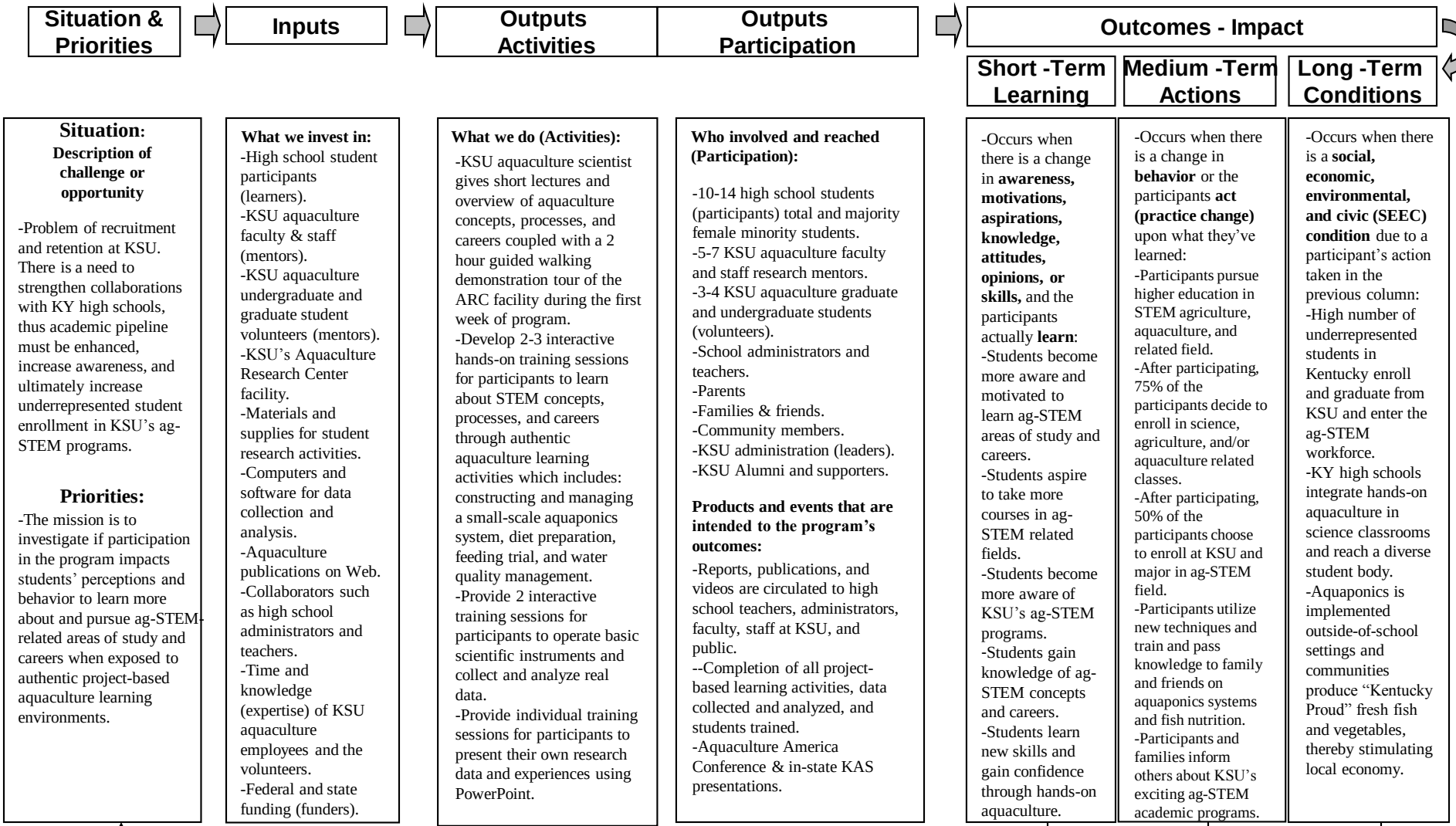
Qualitative data generated included field observations of participants' activities, written questionnaire responses, journal reflections by students, and open-ended interviews. Notably, the same instruments were not used across all three programs. However, inductive data analysis methods were used across all programs to identify patterns that emerged in the data revealing secondary students' knowledge, ideas, beliefs, and attitudes as a result of their participation. The data analysis involved an iterative process of data coding, management, interpretation, and verification of data and it continued until dominant themes had been refined and isolated that represented the participants' experiences, perceptions, and behavior. The research methodology of this study was exploratory-based as well as open-ended systematic inquiry to identify participants' perceptions of their learning experiences. It is believed by the authors that qualitative methods were most suited, since it provides an in-depth understanding of people's experiences in a specific environment and this method of inquiry allows stories to be told in context and compiles evidence drawn from several methods of data collection.

Themes that emerged from the analysis demarcated how experiences conducting hands-on activities and projects helped students to develop conceptual understanding of targeted

aquaculture concepts and self-confidence in their perceived abilities to explore new phenomenon. Results also demonstrated that authentic aquaculture projects enhanced students' awareness of, interest in, and motivation toward learning more about STEM areas of study and careers. Overall, results suggest that students gained important decision-making, occupational, and teamwork skills as a result of their learning experiences in these mentorship programs.

Results from these pre-college mentorship program's may help others develop and cultivate similar experiences for secondary or even college freshman level students and the long-term outcomes includes the following: a higher number of underrepresented students graduate from KSU and eventually join the STEM workforce throughout the United States; Kentucky high schools will engage and reach a diverse study body while integrating hands-on, project-oriented aquaculture in their science and agriculture classrooms and thereby increase the opportunities for enrollment in KSU's ag-STEM programs after graduation; hence, this program theory model will help address the problem of low STEM proficiency and college enrollment of Kentucky students and provide students firsthand knowledge of the broader educational and career opportunities in STEM agriculture, aquaculture, and related fields; teachers will become more aware of ways to encourage students to appreciate and like science if they introduce aquaculture in their classroom/laboratory settings; results of this program will allow educators to better understand how to increase the number of underrepresented students entering higher education in the pursuit of ag-STEM degrees through hands-on PBL using aquaculture as a tool; information of the results disseminated to the public ignites wide-spread aquaponics operations throughout various communities and allow enthusiasts to produce locally-grown fish and vegetables that are sold at farmers markets and nearby restaurants; and the local economy is stimulated and new opportunities are presented to families and individuals to produce healthy foods in their community (Figure 1).

Figure 1. Logic Model or "program theory" for evaluating if a project-based learning program through hands-on aquaculture activities affects high school students' perceptions and behavior to learn more about and pursue ag-STEM-related areas of study and careers



ASSUMPTIONS –

-Program will broaden student experience through hands-on aquaculture activities and motivate them to explore STEM during and after high school graduation and lead to more diverse group of students pursuing a STEM degree in college. Parents, teachers, and community members will utilize program results. The program will enhance the academic pipeline and develop new partnerships with high schools and increase awareness of KSU's undergraduate Agriculture, Food, and Environment (AFE) degree and enrollment.

EXTERNAL FACTORS –

-Model success depends upon the linkage between KSU and participants high schools and relationships established with teachers and parents. Time constraints to finish aquaculture activities due to unforeseen events such as purchase orders at KSU do not get approved in time to buy materials and supplies and/or slow funding allocations occurs from grant agency. Participants must leave program early due to personal issues at home, thus evaluator is unsuccessful in collecting qualitative research data from the entire pool of students.