

STEM on the Road: The Soft Side of Recruitment

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Abstract

There are many types of work that fall under the STEM (science, technology, engineering, and mathematics) umbrella that students often do not consider when making career choices. Manufacturing and healthcare industries, government, and philanthropic agencies are among those that continually push future generations to pursue careers in STEM-related fields. As exposure to STEM careers expands, higher education recruitment and outreach efforts become more varied resulting in camps, workshops, or other short sessions that focus on helping prospective college students understand the various aspects of STEM disciplines.

This paper details how Purdue University Northwest (PNW) took a novel approach to STEM outreach by developing a peer-to-peer “STEM on the Road” (SotR) program. This initiative took the emphasis off recruitment and placed it on STEM college students sharing their collegiate competition and individualized research projects with high school and middle school students. The program helped the college students transport their projects, whether they were small hand-held electronics or full-sized competition vehicles, to area high schools and middle schools for a one-day exhibit. While on-site, the STEM students spent the day sharing their research, discussing the transition from high school to college, and mentoring their younger peers.

Details of the grass-roots history of this initiative are included. How STEM on the Road was launched using internal funding sources will be explained along with how the initiative pivoted during the global pandemic to offer a “STEM on the Net” version of itself. The current state of the initiative will also be discussed to show how it has evolved to support changes in the University’s strategic plan for diversity.

Introduction

Retention and recruitment (R&R) activities are a major focus of higher education institutions as they struggle to maintain enrollments and expand programs focused on STEM fields [1-4]. Purdue University Northwest (PNW) has developed a thriving STEM initiative that supports retention and recruitment without being an actual R&R activity. The STEM on the Road (SotR) project involves monthly peer-to-peer outreach events in which university students visit middle schools and high schools. While there, they share their engineering competition vehicles or science research and demonstrations with interested students. The PNW students also talk about how they transitioned from high school to college at these events, what it is like being a college student, and how they were able to get involved in projects as undergraduates.

One of the most unique aspects of STEM on the Road is that it was conceived and initiated as a student and faculty-led effort rather than a recruitment and retention event initiated by the administration. While not intentionally designed as a recruitment and retention program, the SotR project has nonetheless provided for many of the foundational aspects that researchers have shown are key for any R&R activity. Vincent Tinto, in his classic work on retention, identified one of the keys to effective retention as building a strong sense of inclusive educational and social community [5]. The SotR events were originally initiated to share, on a peer-to-peer level with high school students, what STEM projects, activities, and careers can look like.

While the actual events are largely student-run, the administrative aspects of STEM on the Road are handled by a handful of university faculty and staff. They organize the events, make contact with high schools, and solicit student volunteers from the collegiate competition teams and research clubs. As a result, they have provided an environment where student researchers and competition club members can come together to share their passions with like-minded high- and middle-school students. Additionally, their work has set a foundation for a unique educational and social community of students that is ripe for increasing recruitment among regional high school students as well as retention of the involved STEM students.

STEM on the Road is not a traditional university recruitment event. Instead, it is a highly effective outreach event. Research shows that outreach is a worthwhile activity with a primary aim to inform or spark interest but not necessarily to facilitate enrollment or long-term persistence. Recruitment goes one step further than outreach; in addition to sparking an interest or expanding career knowledge, it also seeks to enroll students in their first courses for pursuing a STEM major [6]. In this regard, the college students, faculty, and staff that developed the SotR activities were very careful to keep the focus on sparking younger students' interest in STEM activities and leaving the act of enrolling students to the university's admissions staff at a later time. Indeed, during the first five years of the project, the university admissions staff was not even involved with SotR. PNW students simply focused on what they knew best; how to have fun with STEM while hanging out with their friends, acting as peer mentors to younger students, and learning from their own mentors. They knew this would allow them to get the word out about all of the STEM-related activities (such as race competitions) that many high school students were not aware fell under the STEM umbrella. While doing so, they served as unofficial university ambassadors, representing the possibilities available to PNW students.

The faculty and staff that worked to support the SotR activities knew that this initiative had explosive potential that would benefit everyone involved. College students would get to mentor younger students, sharing their experiences and accomplishments. Secondary school participants would get to learn of opportunities for careers that they may not have realized were associated with STEM. The high school and middle school counselors, teachers, and administrators were given an opportunity to make connections with external colleagues while exposing their students to enticing activities that were much more engaging than a typical college recruiter sitting behind a table banner handing out swag and pamphlets. For instance, many students were unaware of

the science of researching inks for use in forensic investigations prior to engaging with a student who was doing work in this area.

Among the most useful outreach strategies is “word of mouth” communication through peers, instructors, or counselors; among the least is high school recruiting events. Effective role models not only provide information about their careers but also share with students the challenges they had to overcome along the way. Such individuals are the most effective way for motivating students and getting them initially interested in STEM careers[7]. This is particularly the case when the college students are graduates from the school being visited. In these cases, the students were able to directly model the path from high school students to STEM practitioner.

The Evolution of STEM on the Road

PNW launched the grassroots SotR initiative in 2016. Based on a similar, albeit smaller, program created by students at Purdue University West Lafayette, the broad outlines of PNW’s STEM on the Road initiative were put into place. Concurrently, the College of Technology at PNW had recently purchased a race trailer for use by the Society of Automotive Engineers (SAE) Baja race team to transport their vehicles to the competition. The Dean of the College of Technology invested in this trailer as a way to support competition activities within the College with anticipation that the logo-wrapped trailer would also function as a rolling advertisement. Around the same time, the Dean of the College of Engineering and Science invested in a similar trailer for additional student competition activities led by faculty and students in the College of Engineering and Science. These two trailers were subsequently exploited as traveling billboards by the STEM on the Road initiative.



Fig. 1. Logo wrapped racing trailers.

The College of Engineering and Sciences and the College of Technology teamed up and held the first STEM on the Road event in September 2017. There is much literature focused on large

scale recruitment and retention projects that have been designed and conducted with external funding support. At PNW, no external support was available, so the Colleges fully funded the initiative. Costs for the 2017 and 2018 events included doughnuts, snacks, and lunch for the college students, and gas and rental fees for trucks to pull the trailers.

A small team of faculty (competition team advisors), staff (academic advisors and various college support staff), and Associate Deans of the colleges took care of executing the logistics for each event. Students from the competition teams and research groups participated as their schedules allowed. During 2017 and 2018 six visits took place: one during the Fall of 2017, three during the Spring of 2018, and two during the Fall of 2018. Over time, the goal became to conduct three visits per semester. Fewer visits reduced the regional impact of SotR; more impinged on student schedules, reducing their availability. Every event was unique as the makeup of the program was based on the aforementioned availability of the collegiate competition club members and student researchers. Some of the participating groups are included in Table 1.

Table 1. Participating competition clubs and STEM researchers.

Construction Club Surveying Demonstration	Electric vehicle Research
Society of Hispanic Professional Engineers (SHPE)	SAE Baja Motorsports
Mechanical and Civil Engineering Demonstrations	SAE Formula Race Club
American Society of Civil Engineers-Concrete Canoe	Biology research
Institute of Electrical and Electronics Engineers	Chemistry research
CyberCorps Cyber Forensic Research	Physics research
Environmental Health and Safety Research	Forensics research
(NFPA) Fluid Power Vehicle Challenge	Medical Career Club
Barker Mansion Research Project	Robotics Club
Human exploration rover vehicles	Society for women Engineers
Computer Graphic Gaming research	Van de Graaff demonstration

Figure 2 shows some typical interactions of the collegiate competition club members interacting with high school participants.



Fig. 2. High School visit with STEM competition vehicles.

The visits were typically held on Fridays between 9:30 to 1:00 pm. This meant that the SotR participants met to load the trailers at 7:00 am and finished with a pizza lunch back at the university that ended around 2:00 pm. The students all volunteered and were surprisingly energetic even at the end of a long, physically stressful day of loading the trailers, setting up, tearing down, reloading the trailers, and putting everything away at the end of the visit.

During 2017 and 2018, the targeted high school visits were arranged based on the high schools that were the largest feeders to the university's programs (Table 2). These choices were made based on either raw numbers or percentages of the graduating class matriculating into PNW. The latter led to the inclusion of smaller regional schools than would normally have been considered. Additional effort was made to spread the schools over the complete coverage area of PNW. This ran from the western Indiana state border to the border of Michigan and included schools in Lake, Porter, and LaPorte counties in Northwest Indiana.

Table 2. High school graduates attending PNW University

School	Region	Number of FTIC	Percent of Graduating Class
Lake Central HS	West	84	12%
Crown Point HS	Central	53	8%
Chesterton HS	Central	46	10%
Morton HS	West	43	21%
Lowell HS	West	40	16%
Munster HS	West	40	12%
Portage HS	Central	37	7%
LaPorte HS	East	33	9%
Merrillville HS	West	32	8%
Highland HS	West	31	13%
Hobart HS	Central	28	9%
Griffith HS	West	27	18%
Kankakee Valley HS	Central	26	11%
Michigan City HS	East	23	8%
Valparaiso HS	Central	22	5%
George Clark HS	West	18	15%
Whiting HS	West	17	19%
Hanover MS	West	15	10%
Andean HS	Central	14	12%
Washington Township HS	East	12	20%
Westville HS	East	10	15%

At the time, this was appropriate to support the main goal of outreach to the university's incoming student population, namely exposing them to and sparking their interest in STEM-related fields. There were many varied research projects shared during the visits (Figure 3).



Fig. 3. Various collegiate research projects.

In 2019, an industry partner became aware of the SotR visits within the community and provided a \$10,000 gift to support the initiative. With this, the SotR team purchased additional items to further brand the events and help the students feel even more of a sense of identity. This included swag raffle bags which were used to entice high school students to sign up at the events so that data could be gathered regarding how many and who was attending the events; tablecloths to advertise the event on site; and T-shirts were branded with a STEM on the Road logo that was created in-house (Figure 4).



STEM on the Road logo and T-shirts



Fig. 4. STEM on the Road SWAG bag.

The Effectiveness of Peer-to-Peer Mentoring

The peer-to-peer mentoring at these visits supports the observation that this type of engagement sparks interest in STEM. The literature also suggests that undergraduate research needs to be branded into the culture of STEM so that we can effectively communicate the significance of research and can bolster the engagement of STEM students in science and engineering degrees [8].

Research in STEM is very wide in breadth. It can include researching architectural drawings and physical construction sites to recreate historical buildings virtually or as scaled physical models as one research team did with the Barker Mansion project; designing, raising funds for, fabricating, and participating in a vehicle competition, as our Baja team did; explaining the science of electricity and curved space, or even learning about insects from half-way around the world by handling them (Figure 5). Whatever the STEM project or research may be, it is important to be able to get the research items on-site with the students so that they can physically engage with the experiences as is done with SotR.

Similarly, the use of peer-to-peer mentoring has a significant impact on high-school students. Based on feedback from the high school teachers and administrators, those students who were already considering college had that choice reinforced. At the same time, their engagement increased their interest in STEM disciplines and their knowledge of the opportunities available to them as PNW students. Students who were not considering college left the event more excited about the idea that they too could succeed in college and enter a STEM discipline.

Barker Mansion research project



Forensic research



Physics research



Fig. 5. Various collegiate research

Pivot during Pandemic

Enthusiasm was running high as the STEM on the Road team moved into 2020. The first two programs were well received by the targeted schools, but the start of the COVID outbreak caused

the final visits scheduled for March and April 2020, along with the Fall 2020 visits, to be canceled.

With all that had been done so far with the SotR initiative, the PNW students in the STEM fields were very anxious to continue to mentor area high school students even during the pandemic shutdown. They had gotten into the routine of making connections by visiting area high schools/middle schools once a month through the STEM on the Road events. With safety at the forefront of everyone's agenda during the pandemic, the college students pivoted in their mode of delivery for making peer-to-peer connections by taking the time to modify to a virtual format. The collegiate competition groups and the research groups created alternative formats and rebranded themselves as STEM on the NET.

STEM on the NET, while not nearly as sought after as STEM on the Road, strengthened the college students who were caught in the disconnect from their peers that was prevalent during the shutdown. The event organizers noted that while only one high school/middle school requested a visit in the altered STEM on the NET format, the real impact was in bringing together the student mentors, faculty, and staff to design and deliver the altered event. Organization for the altered format began in December 2020. All of the development was done over Zoom. Outreach was made to high schools to determine the logistics for the events in this new format. The challenge was to develop peer-to-peer activities that could be done virtually at different schools because each high school had its own online layout for its school day.

The students, faculty, and staff kept in mind the goal of any in-person event, which was to provide STEM college students an opportunity to reach out to high school peers in order to showcase the projects that they are involved in at the college level. One thought for the alternate format was to keep the interactions short by possibly showcasing a different club each week instead of just doing one big STEM on the Road event each month as was done with the face-to-face format. The student competition and research clubs that participated in designing alternative virtual formats included the Baja vehicle competition, the American Society of Mechanical Engineers, the Solar Car Competition club, the Steel Bridge Competition Club, IEEE, the Concrete Canoe Competition Club, and the Forensic Club. After 2 months of planning, three engagement activities were rolled out during a high school/middle school virtual visit in February 2021:

- 1) IEEE developed a hands-on engagement activity for the high school students in the classroom to explore electricity. They created a small kit (Figure 6) with an LED, battery, and pencil which was packaged and sent to the school prior to the event so that the teachers could hand out the kits to the students in their classrooms or send them to those students that were attending at home. The goal of the activity was to simply draw leads and get the LED to light up while learning about electricity. The IEEE college students then walked the high school students through the activity. There were many "Yeahs!" and shouts of amazement when the high school students achieved success on their end.

- 2) The Baja competition club had several students attend remotely while others were on-site at the university with the Baja vehicle. They drove the vehicle and conducted a demonstration while it was live streamed to the high school class. The college students then used cameras to walk the high school students around the university's manufacturing lab where they design and produce many of their vehicle parts.
- 3) The forensic club developed an interactive crime scene on the web that the high school students connected to and then worked through, solving the case as the college students explained what was happening in the scene. The remote students then used Kahoot for responses as the high school students attempted to solve the crime.



Fig. 6. STEM on the NET IEEE engagement kits.

While STEM on the NET was a welcome break for college students working independently at home, the virtual format was in no way equivalent to the face-to-face interactive STEM on the Road. However, it is believed that holding meetings over the two months of planning the alternative format did help with student mental health and, based on reported retention numbers, inspired student retention at the college.

Getting Back on the Road

The SotR event organizers have had difficulty collecting true outcomes data in support of the project. During the first few years when the events were run, surveys were created to gather data from high school participants. However, these surveys were difficult to collect and the ability to correlate and track students that attended a SotR event was not possible. For 2021 and 2022 the SotR organizers chose to track the attendance of participants via lists generated as students signed up for SotR SWAG raffle items. These lists were then provided to the university admissions office so that tracking will be possible in the future as high school students enter

college. Over time, this data should allow the project organizers to determine the number of students that actually attended a STEM on the Road event and then went on to enroll at PNW in a STEM major. The next step will be to develop benchmark data and other significant factors that may be of interest to future recruitment initiatives. Various data were considered for tracking and evaluating the project when it was first initiated. However, due to multiple environmental and social factors, it was not possible to make a direct correlation.

As previously stated, the SotR organizers originally targeted the existing high schools that were high-feeder schools to PNW. While partnering with these schools did allow for PNW college STEM students to conduct peer mentoring, it was noted that the number of students and percentages of students enrolling from these schools were already high. If the goal of SotR was to be recruitment, the schools that are already high-feeder schools to PNW are not the schools to be focusing on. Were the enrollment rates from these schools already saturated? Did these schools have higher enrollment rates at PNW because students had the means to go to college rather than consisting of lower-income populations that may not have the means but who, if enrolled, would even out the diversity of our student population to better mirror that of the region? Through answering these questions, it was decided that by reaching out to schools that are more representative of the diversity of the region, more connections could be established with the hopes that, overall, the number of students from these schools would actually increase. If we could use SotR events to make this happen, then we possibly could incorporate some additional recruitment initiatives into SotR events.

As of 2021, the SotR organizers still focused on SotR as an outreach event with the main goal being to connect PNW STEM students with the community. They recognized that ultimately SotR should also be attempting to increase the diversity of students that enroll in PNW STEM majors. With at least three SotR events each semester, SotR already has the traction needed to expand outreach to additional area high schools. When the high schools reopened for on-site visits after the pandemic, SotR was positioned so that the students were ready to engage once again with the high schools and middle schools (Table 3).

Table 3. High schools visited by SotR.

School	Date Visited 2017	Date Visited 2018	Date Visited 2019	Date Visited 2020	Date Visited 2021	Date Visited 2022	Date Scheduled 2023
Munster HS	9/29/2017			2/14/2020			
LaPorte HS		3/2/2018					
Hobart HS		3/9/2018					
Lincoln Way HS		3/23/2018					
Lake Central HS		10/19/2018				10/21/2022	
Michigan City HS		11/2/2018					
Portage HS			1/18/2019				
Crown Point HS			2/8/2019				
Valparaiso HS			3/8/2019		11/12/2021		
Chesterton HS			9/13/2019				
Westville HS			10/11/2019				
Washington Township HS			11/1/2019				
Kankakee Valley HS				1/31/2020			
Homewood-Flossmore				2/28/2020			
River Forest HS				*2/26/2021	10/15/2021		
Kouts MS/HS						3/11/2022	
Bishop Noll HS						3/25/2022	
Calumet New Tech HS						9/23/2022	
East Chicago Central HS						11/18/2022	
Morton HS							1/27/2023
Joseph L Block MS							2/24/2023
Whiting HS							3/24/2023

*This was a virtual visit as STEM on the NET (conducted during the pandemic shutdown of schools)

The Bigger STEM Picture

STEM on the Road is just one aspect of STEM outreach. As community connections were made over the years through the SotR project, many additional opportunities arose for STEM activities to take place between the community and the university. The lead coordinators of the SotR project noted that external stakeholders have little concern for internal operations and artificial barriers that organizational boundaries had created. When a high school administrator, counselor, or instructor reached out to explore the STEM disciplines offered at the university, they assumed that the STEM on the Road coordinators were their connection to all of the various STEM disciplines (Science, Technology, Engineering, and Mathematics) at PNW. However, at PNW, these disciplines are housed under the auspice of the College of Engineering, Math, and Science (EMS) and the College of Technology (COT). Additionally, event coordinators found that in addition to the traditional STEM areas, external stakeholders also viewed the sciences as expanding into healthcare, which created a tangential connection to the College of Nursing (CON). Therefore, the SotR coordinators were tasked with transcending the organizational boundaries to make sure that they represented any program that external stakeholders were searching for.

To this end, the associate dean for the College of Technology and the associate dean for the College of Engineering and Science developed a common persona, STEMconnections@PNW, which allowed for a central communication email stemconnections@pnw.edu so that they could connect inquiries to the proper unit within the university, regardless of STEM field or activity inquiry.

This one connection gave external stakeholders a one-stop shop to find out about numerous opportunities that existed to connect high and middle schools with any of the STEM outreach activities at the university, including

- High school students could connect with college students focused on STEM fields through STEM on the Road or STEM on the Net.
- High school teachers, counselors, and administrators could connect with STEM faculty and administrators through STEM Connections Breakfasts which were offered once in the Fall and once in the Spring.
- High school teachers could set up STEM campus tours for their classes.
- STEM college faculty were open to connecting with High School students in the classroom through various lecture series and research opportunities.
- High school students could participate in internships working with researchers.
- STEM Summer Camps and Winter Break Camp information was available.

Existing literature highlights that many of these types of activities and others discussed in this paper, such as faculty-directed research projects, internships, and mentoring, have also proven successful as retention-focused interventions for STEM major retention [4].

Broader Impacts and Benefits

Although STEM on the Road is a peer-to-peer outreach program that focuses primarily on students in the College of Technology and the College of Engineering and Science, it is anticipated that it will have broader impacts on the university community as a whole. With slight modifications, SotR can easily become more directly tied to university efforts of recruitment, retention, and increasing diversity.

- **Recruiting:** As discussed earlier, there are many foundational components to recruitment already present in the SotR visits. It is anticipated that some of the SotR student participants will become university peer mentors and hired to play an active role in student recruiting.
- **Retention:** Although Tinto's classic theories on retention are not STEM specific, the ideas apply to STEM departments as entities within institutions. For example, the cultural theory proposition, "Students who belong to one or more enclaves in the cultures of immersion are more likely to persist, especially if group members value achievement and persistence", supports that SotR is an activity that enables students to establish kinship within STEM which can lead to increased retention in university STEM programs [5].

- **Diversity:** For the 2022-2023 academic year, five of the six planned SotR visits focus on Hispanic serving institutions as an intentional shift to increase the Hispanic population of the university.

While recruitment and retention rates are impacted by many factors, for a regional University, having local STEM on the Road events can be a major contributing factor to the visibility of their STEM programs throughout the area. With the COVID shutdown, it was anticipated that recruitment and retention rates would not be maintained but retention results did hold fairly steady over the years prior to and after the pandemic.

Table 4. Retention rates.

PNW	Retention Rate			
	Spr19 to F19	Spr20 to F20	Spr21 to F21	Spr22 to F22
College of Technology	84.46%	86.77%	86.90%	87.09%
College of Engineering & Science	87.52%	88.79%	86.24%	84.80%

Conclusion

STEM on the Road is in its sixth year of production. There have been twenty-three visits to nineteen high school/middle schools with three additional visits scheduled to be held during 2023 and reservations for visits are already being made for the 2023-2024 school year. Whereas original efforts to connect with high schools and middle schools required extensive hours of outreach by university staff members making appropriate connections to local schools, today the area high school and middle school administrators, counselors, and teachers reach out to PNW STEM on the Road coordinators a year in advance to reserve their STEM on the Road event. It is akin to recruitment in reverse.

Likewise, twenty to thirty college students from eight to fifteen STEM collegiate teams and research areas continue to volunteer their time to participate in each STEM on the Road events. The student responses are always the same upon return from an event; they are energized from mentoring future STEM students and they look forward to being involved in the next event. The feeling of engagement that SotR events create for involved college students is very strong. It develops a sense of purpose and belonging in them making them want to stay involved, or in other words, it supports the retention of students in their STEM programs and the university. While SotR was initially developed as a peer-to-peer mentor activity for students in STEM fields, it has evolved into an outstanding recruitment and retention activity for advancing STEM awareness and engagement in the community for Purdue University Northwest.

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Biographies

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