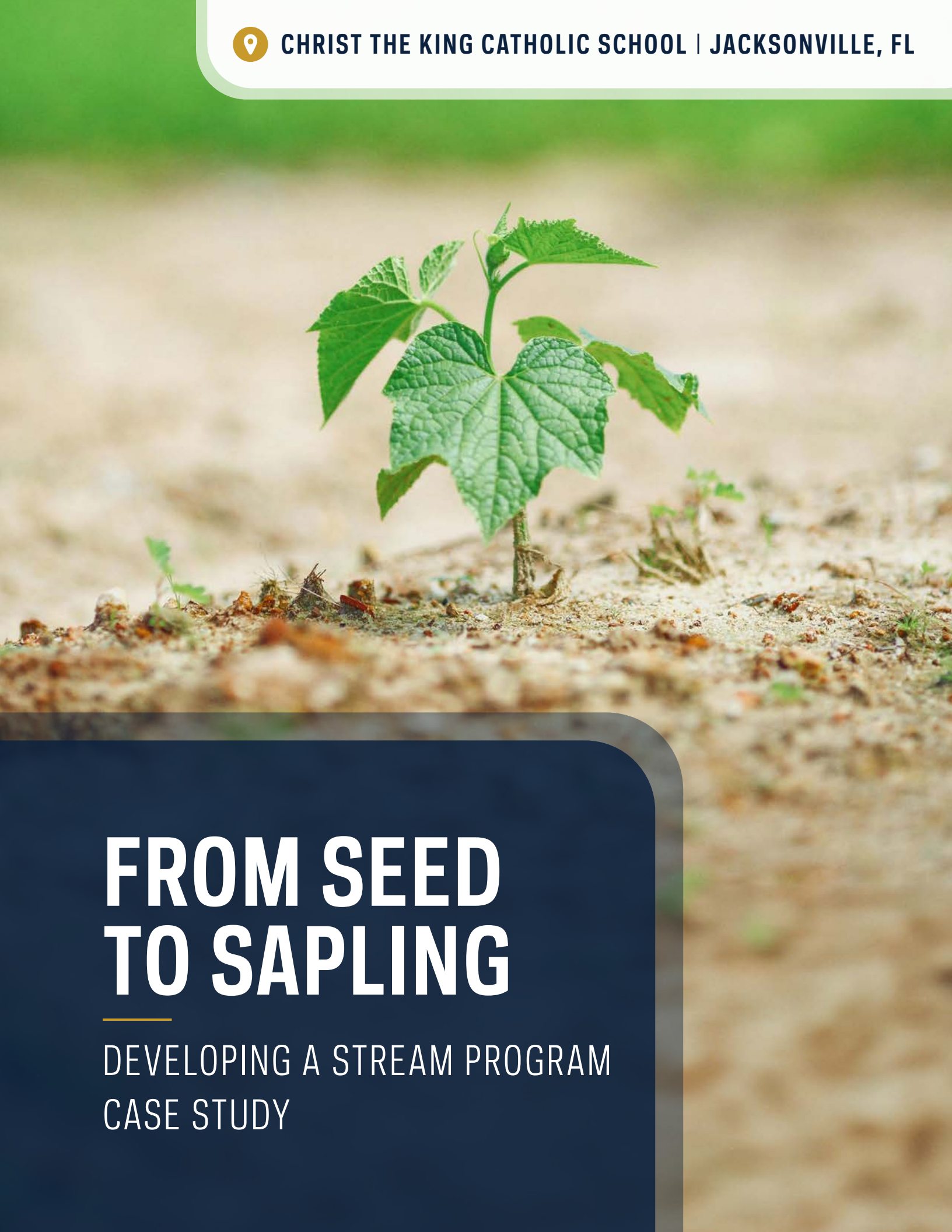




FROM SEED TO SAPLING

DEVELOPING A STREAM PROGRAM
CASE STUDY



EXECUTIVE SUMMARY

Christ the King Catholic School features a cohesive set of thematic STEM-related projects for every grade level in which students are provided with real-world contexts to consider how Catholic values and perspectives can inform their interactions with the natural, material, and built world. Each grade level focuses on a project throughout the year that is embedded in the school's local context and utilizes available resources (either on school grounds or locally) that are connected to themes of agriculture and the environment.

Cultivated over the course of a decade, the school's program makes use of acquired materials and infrastructure to engage all students from kindergarten through eighth grade in immersive "STREAM" learning experiences that connect multiple subject areas across the STEM disciplines, religion, and the arts. These extended, real-world projects serve as a tangible way for students to experience how the Catholic faith calls them to be a participating member of their community and to impact it for the better. These efforts have earned it the designation as a STREAM school by the Florida Catholic Conference.

HISTORY & MOTIVATIONS

Christ the King's STREAM program was born from a strong vision set out by an experienced school leader over the last decade of her career, as she aimed to solve an acute problem.

Located on the downtown 'rim' of Jacksonville, Florida, the school had begun bleeding enrollment as parish families moved further toward the suburbs, and the once-bustling school campus was dwindling in numbers. In pursuit of attracting new families, the school leader set out to research different ways that might set the school's educational offerings apart. Informed by a group of stakeholders, Christ the King ultimately pursued an emphasis on STEM education, with the idea that each grade level should have its own year-long STEM project. From its inception, the program has been rooted in two core commitments: first, to offering local, real-world STEM learning opportunities that position students as authentic problem solvers, and second, to draw direct connections, as a Catholic school, between each project and how it relates to the Catholic faith.

The principal began by recruiting and hiring a STEM coordinator, who spearheaded the first curricular adoption for integrated units across the elementary grades. Then, for the middle grades, the principal adapted a project structure she learned about from a STEM-certified public school in an adjacent state, in which all the middle school teachers collaborated and co-planned a unified large-scale project that rotated year-to-year. The first such 'universal mission' project focused on how to improve the lives of immigrant farmers, which entailed partnering with a Catholic parish involved in immigrant outreach, visiting with immigrants and learning about crop-picking, designing a model to address a need within the community, and developing a faith statement around the project.

Since then, the school has adjusted and altered these projects, refined the STEM resources and training used by its teachers, and incrementally added to and extended its STEM infrastructure. Each grade level, beginning with kindergarten, now focuses on a year-long project embedded into its curriculum and aligned with grade-level learning standards. The rotating universal mission project sits now as the capstone engineering project for eighth grade students. Each project is thematically linked either to an agricultural or an environmental issue, with each making use of locally available assets, whether on school grounds or in the surrounding area. The school infrastructure itself shows evidence of this developing realization of STEM opportunities: there are outdoor garden beds, an aquaponics system, solar panels, 3D printers, extensive collections of robotics and LEGOs, and a beehive, to name several. Across all of these projects, teachers are expected to make explicit ties to the Catholic religion, with most doing so by applying Catholic values to the localized and meaningful context of their projects.

These efforts have been externally validated, with the school earning federal recognition as both a Blue Ribbon and a Green Ribbon school. The school has been certified by the Florida Catholic Conference as a STREAM school, with an added 'R' for religion to the conventional

STEM designation (as well as an 'A' for 'arts'). The accrual of these designations hearken back to the impetus to market the school as an attractive option for families, which has come to fruition: the school has increased enrollment by over 100 students, with the total enrollment surpassing 350 students. These recognitions now offer validation of a high-quality learning experience for students.

PROGRAM CONTOURS

The shape of the STEM program is now well-established within the school's self-identity. The dual commitments set out over a decade ago remain central to the program's ongoing maturity, a notable continuity given the founding principal's retirement and transition to new school leadership. Many of the grade-level projects are now highlights of the educational experience at Christ the King, offering immersive learning opportunities that are treasured by students, parents, and the local community. Both administrators and teachers also voice a strong and stable commitment to link these learning experiences to its identity as a Catholic school, although this is paired with a desire to strengthen how these STEM projects can enable students to enact and live out the Christian call to care for others and for the created world. Three short vignettes help illustrate the current contours of the program:

HATCHLINGS ON ARRIVAL

It is not yet 7:00AM when Ms. Wembley, the STEM coordinator, walks through the simple metal-frame entry door. "We have two of them!" shouts the first grade teacher, with excitement from down the elementary hallway. Ms. Wembley quickly puts down the boxes in her arms and heads down the hallway toward a folding portable table set along the wall. On top is a glass enclosure, with a red light shining into it and emanating heat; inside, two dispensers that look like bird feeders are latched to the sides – one for water and one for food. Beside it on the table is a small, circular incubator, no larger than 1 foot in diameter, with a temperature and humidity gauge on its lid.

Ms. Wembley and the teacher work together to remove two new hatchlings from the circular incubator, their attention locked on the two fragile creatures and their dialogue staccato from a combination of excitement and concentration. As they remove the chicks one-by-one, the teacher interjects: "I'm not sure what I'm doing!" Ms. Wembley's evident expertise and calm demeanor steadies their progress; one at a time, she firmly grips the chicks and transfers them to the terrarium, holding each first to the water dispenser before putting them down. The teacher watches the chicks intently. "Oh, look! They are so tired. That one is just laying down under the heat lamp, like it can't be bothered by the others!" Back and forth, the two educators trade remarks of attentive wonder: "Look! It's almost like falling asleep with its head up, and then its head falls back down."

A laminated poster titled “1st Grade Agriculture” hangs on the wall a short distance away; visually, it shows several pictures of chickens, and children holding chickens, at various stages of development. It reads:

We learned:

- about the life cycle of a chicken by incubating and hatching eggs.
- about agriculture by planting, growing and harvesting in our garden.
- to share our scientific knowledge through journaling and data collection.
- About nutrition by making applesauce and sharing our lettuce crop with friends and family.



SOLAR POWERED

Three 6-ft x 3-ft solar panels line one of the school courtyard walls, each mounted about 4 feet off the ground and angled toward the afternoon sun. These panels capture renewable energy from the sun, which, alongside other elements, contribute to the school's recent designation as a Green Ribbon School for its commitment to reducing environmental impact and providing sustainability education opportunities for students. Teachers were getting trained, too, with the teachers needing to become certified 'green classroom teachers.' The timing could not have been better for this Catholic school, as the emphasis on environmental care was taking hold in Catholic communities on the heels of Pope Francis's encyclical *Laudato si': On care for our common home*.

Christ the King's fourth grade students are responsible for maintaining and monitoring these solar panels. This project is tied to fourth grade learning standards related to the science of energy transformations, but it is also leveraged for mathematics by exploring the data that is collected to analyze energy usage, represent this data to make sense of it, and consider its implications. "Instead of just analyzing the data and moving on, we talk about what that means," explained one teacher. "We talk about the impact that it has on our community, we talk about the impact it has on the environment and the people living in our community, and all of those things... We get to have those conversations about how it affects people and what that means for us as God's creation." The project is an opportunity for students to consider sustainability issues related to their usage of energy and how to take the burden off of the energy grid, with an intentional connection to Catholic Social Teaching. In the process, students are able to discover their own agency in being good stewards of God's creation – like figuring out how the school campus can reduce energy usage.

JUNIOR MASTER GARDENERS

Twenty 5th grade 'junior master gardeners' sit along the cement-block edge of a raised garden bed at 2:20pm, with their feet on the grass in the sunny courtyard. Most are wearing their PE uniforms: dark blue shorts with a name patch near the hem and gray t-shirts with a printed name-tag space on the chest. Ms. Wembley, the STEM coordinator, welcomes the class and quickly distributes tasks to the students in front of her. "Last week, if you were trained on hydroponics, you will do that job for the rest of the quarter..." Dismissed, four students quickly pop up and head over toward the classroom patio where the hydroponics system is. She continues, "We need two full sprinkling cans to go on each pineapple plant... Who wants to water pineapples?" Students raise their hands, and Ms. Wembley counts off four students. She continues, and in under five minutes all students are off and doing gardening tasks in pairs, threes, or fours.

Two students – one boy and one girl – fill up their water cans from two raised water barrels that have gathered rain water from a covered walkway across the courtyard. A portion of gutter on the overhang is directed into one of the big barrels. There is a sign next to the barrels that reads,

"2013 | 8th Grade Engineering | Water Collection System." The girl takes notice of her watering can: "There's a lizard in my watering can! It's alive!" She is talking now with the boy, "It came from there," pointing to the gutter. The boy looks up and around. "I think it hopped in over here," he says, "There's no way that it would have fit over there." "Yeah, I see!" the girl responds with excitement.

At one of the raised garden beds, a middle-aged volunteer is working with three girls. Her day job is as a realtor, but she has been volunteering with Christ the King for the past seven years, following her training in an eight-week course as a 'master gardener' at a nearby university. One of the girls is using a shovel to dig out a hole in the soil, while another girl helps transplant a small plant with several leaves. They are moving planted starters from near a tomato plant out into a different part of the bed. They are too crowded, explains the master gardener. "Next week, we'll be able to move these other ones, too."

A handful of students are engaged in a discussion as they walk by. "Arugula's spicy!" exclaims the first. "No it's not," contends a classmate. "Yes, I took a bite out of it. It's really spicy." A third student joins in, "I don't know why it tastes like that! It's disgusting!" She turns to the STEM teacher aide, makes a face like she doesn't like the taste, and asks, "Can I get a drink of water?" The first student wonders aloud, "Maybe arugula is that thing they put in spices."

At another garden bed, the 5th grade teacher is talking with several students: "These look a lot healthier than last year. These strawberries have grown a lot since last week." The teacher wanders over and begins talking with the master gardener, who remarks, "By the end of the month, this will be full with strawberry plants. It's great when students are able to actually eat the strawberries that they find here."



MAJOR THEMES

These examples help illustrate several themes that characterize how the school has attempted to link its robust STEM program to the school's Catholic faith tradition. Importantly, in this analysis we bound our analysis to the set of vertically-articulated grade-level focal projects that constitute a unified STREAM 'program' that seeks to tie together the Catholic faith and STEM education in content-related ways. Outside of this purview, Christ the King Catholic School offers many additional STEM opportunities, like Engineering Club, and there are varied ways in which the Catholic religion informs students' school experience, from general classroom structures like prayer to teacher's approaches to discipline.

INSTITUTIONAL SAFEGUARDS

Certification requirements serve as one *de facto* external force in ensuring the implementation of the program, yet school leaders have also safeguarded its continued coherence and quality through other top-down measures. Once the grade-level STEM projects were instituted, every teacher contract stipulated that teachers must implement the STREAM program, participate in STEM trainings (e.g. Project Learning Tree), and receive ongoing formation on the Catholic faith (as required by the diocese). The STEM coordinator is also a centralized role, working across all grade levels to ensure the vertical coherence of the program and to lend instructional expertise. The STEM coordinator works collaboratively with each K-5 teacher and across the middle school teachers to implement these grade-level projects.

PUBLIC GRANTS & LOCAL PARTNERSHIPS

Each of these projects require materials and infrastructure. Raising chickens requires not only an incubation station for hatching chicks and an indoor terrarium, but also an outdoor chicken coop. Capturing solar energy requires solar panels and data systems. Junior master gardeners utilize four garden beds, a water catchment system, hydroponic gardens, and a blueberry patch enclosure, not to mention shovels, watering cans, planting containers, soil, and a composting system. Many of these projects have received funding through grants or local partnerships. A \$500 grant was used to purchase an aquaponics system, while a partnership with a local university supports the engagement with a volunteer "master gardener" who co-facilitates the 5th grade STEM period once per week. The STEM coordinator role is the school's engine for securing these STEM resources and opportunities, and they have leveraged public STEM resources extremely well to make the cost of infrastructure feasible.

INTEGRATING FAITH WITH STEM LEARNING

In order to integrate a religious dimension, teachers are tasked with the creative endeavor of adapting these materials and resources from the public sector. Teachers and school leaders place significant value in doing so, but to a person each noted that there were few, if any, resources known to them about how to connect STEM learning to the Catholic faith. Within this strongly shared commitment, teachers represent a diverse range of approaches for conceptualizing how to connect the Catholic faith tradition to students' STEM learning experiences. The year-long projects – with their real-world applications – served as one of the most tangible ways for students to consider how Catholic values can transform their participation as part of their community. Students, parents, teachers, and administrators highlighted their school's farmers market that sold produce and other school-produced goods (e.g. honey, eggs) to parishioners and the broader community as a prime example. The student-led effort raises almost \$3,500 annually for the nearby L'Arche community where students get to know the residents.

Teachers' perspectives on connecting the Catholic faith to STEM-related learning were notably varied. Life science was consistently identified as the strongest point of connection to the Catholic faith, with many teachers connecting it to the Catholic Social Teaching principle of



caring for God's creation. Several teachers noted how the Catholic school environment generally enabled discussion of students' questions about how religious ideas relate to school topics, like evolution, reproduction, or extraterrestrials. Other connections were more idiosyncratic. One teacher, for example, drew an analogy between the ecological study of the cross-sectional rings of growing trees and one's faith journey. Some of these perspectives represented conflicting ideas about what might be beneficial for students. One teacher suggested that faith connects to mathematics not so much through the disciplinary core ideas but through its application in our world, whereas another teacher found value in connecting the rosary to counting multiples of ten. Two teachers reflected – with different tenors – about their approaches to forming young people in the context of a Catholic school; one teacher saw the value of curiosity and questioning for faith seeking understanding, while another teacher emphasized the importance of anchoring belief in the Truth that subsists in the Catholic Church. This heterogeneity reflects the spectrum of spiritual and theological perspectives that teachers bring to STEM education at Christ the King.



IMPLICATIONS & RECOMMENDATIONS

This case study offers a transferable approach for developing a STREAM program rooted in local, real-world contexts that spawns open-ended thinking and considers how Catholic-Christians are called to care for their local communities and environments. From this case, we offer four implications that we consider relevant to K-12 Catholic schools seeking to implement a program aimed at integrating the Catholic faith with STEM education.

A dedicated coordinator role sustains program development. The development of the school's STREAM program has been made possible by the range of responsibilities carried out by the STEM coordinator. The centralized role ensures that the various grade-level projects are present, appropriate, and non-duplicative; it also lends instructional expertise through collaborations with teachers at every grade level. The dedicated role serves as the essential mechanism for obtaining grant funding and for supporting teacher development through in-service PDs.

Leveraging public resources is a waypoint toward integral STEM education. By leveraging public resources like public grants and STEM training, the school now boasts a rich suite of STEM-related infrastructure that enable them to offer valuable learning opportunities without the need for fundraising via a capital campaign. Infrastructure opens up possibilities, but high-quality STEM teaching is necessary for students to engage meaningfully with these resources. At Christ the King, the instructional expertise of the STEM coordinator and leadership's investment in teacher training are capitalizing on the present infrastructure.

Top-down directives should be coordinated with bottom-up supports. School leadership has set forth several top-down directives that have safeguarded the development of its STREAM program (e.g. contract stipulations, required training). These directives have been most effective when matched with momentum from the bottom-up and corresponding supports; the enrollment in a multi-year STEM teacher leadership program for three teachers is one such example. They have been less realized when decoupled from supports. The explicit expectation at the school to integrate religion across the curriculum maintains a high-level of faculty buy-in, yet it is challenged by the dearth of resources for guiding how teachers might authentically do so. Providing explicit professional formation is key to lowering the burden on individual teachers' planning and for ensuring that well-intentioned faculty who may not have expertise that bridges STEM-related or theological content areas nevertheless utilize authentic points of connection.

Developing a STREAM program is an iterative process of refinement. Guided by a clear vision, the program's decade history is marked by a process of incremental growth, accumulation, and intentional pruning, which are necessary for continuing to shape it. Today, the program is evident everywhere on the campus and offers tangible opportunities for students every day. Still, teachers and leaders continue its development, now with greater focus on refining the suite of learning experiences for students so they can engage more deeply in these real-world contexts.

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