



SCHOOL OF EDUCATION
UNIVERSITY OF MICHIGAN

GeT: The News!

Volume 4, Issue 3
Spring 2023

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Toward a System that Curates and Documents Resources for GeT Instruction

by Pat Herbst

The emergent consensus our community has reached on the student learning outcomes for geometry courses for teachers allows us to come back to one of the aspirations of the initial working groups in GeT: A Pencil—the creation of a task repository. Indeed, the collaborative curation of resources for teaching GeT courses could be a next step for our community to cooperate toward the goal of increasing capacity for high school geometry instruction. Along those lines, we hope to submit a grant proposal to support this work; this essay describes some initial thoughts on how that work could be framed.

The notion of *resources* is key in this proposal. Trouche et al. (2020) elaborate what is meant by resources in the field of mathematics education thus:

a resource [is] anything likely to ‘re-source’ the teacher’s practice. It can be a textbook or a website Teachers search for resources, select resources and modify them; they use them in class, and this can lead to further modifications. ... [T]his work is called teachers’ documentation work. (p. 1244)

Resources are tied to technologies inasmuch as they may be produced and modified with technologies. They are also tied to curriculum, inasmuch as curricula are canonical examples of resources, but the concept of resources in the context of instructional practice is more general. Furthermore, the resources approach spearheaded by Luc Trouche and his colleagues differs from approaches to curriculum use that emphasize central planning by authors and fidelity of implementation by teachers. It points to the dynamic interactions between teachers and resources—the latter informing the former, and the former modifying the latter, in ways similar to how Remi Llard (2005) had described some teachers’ interaction with curriculum materials as “participating with” curriculum materials (and contrasting with following, subverting, drawing on, or interpreting curriculum materials). Trouche et al. (2020) refer to the work that instructors do with resources as documentation, noting that the interaction with resources is projected in documents that, for example, attest to changes they made to resources or add observations made in the context of use that might inform future uses.

With the assistance of the concepts of resources and documentation, we can describe more concretely what we could be producing in the next few years. First, rather than producing a textbook, I argue that we should shape a system that can support the documentation of resources for GeT instruction. Further, we should begin to make that system work by putting out resources that might enable individual instructors to pick and choose what would be serviceable for the course they want to teach and support the work of documenting instructors' use. Second, to support the discretionary use of resources and their documentation, I argue that the final destination for the publication of those resources needs to be a digital platform that permits both instructors tinkering with, editing, and augmenting resources, the use of those resources with their students, and the observation of patterns of instructors' and students' use by the community, particularly by those of us interested in understanding how instructors shape resources. Third, the digital publication of these resources also permits us to conceive of the resources that get put out as supporting various kinds of documentation. The customization of a set of curricular resources to compose a course of studies is one canonical documentation, but other traversals of the set of resources are possible to envision as we realize that the documentation process may generate other resources, derivative of the curricular resources.

To be clearer, if we think of a problem as a case of a resource that an instructor could choose to include in their course, other resources that support the use of that problem in class might be developed, linked, and consulted. For example, a set of tags that connect the problem to different SLOs can be one such secondary resource; hints for students that the instructor might provide access to are another example of a secondary resource. Information from research on students' cognition that appraise the instructor of errors to be prepared to see in the context of GeT students' work on the problem can be a third kind of secondary resource. Furthermore, materials derived from early uses of the resource (e.g., students' work) can also be among these secondary resources, supporting other instructors' anticipation of what students could produce.

This brings us back to the design of a system that can support this documentation work: The work the community may get to do includes specifying the workflows and task descriptions needed for the community to produce all of these resources. This may include many of the activities often thought of as part of curriculum development process (e.g., drafting, disseminating, piloting, assessing outcomes, revising, etc.) but with a focus more on community and systems development through the production of resources than on the production of a final set of resources. A community like ours can organize itself for the work of continuously improving its instructional resources; this can be our next step in the trajectory toward improving capacity for high school geometry instruction.

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Suggested Citation

Herbst, P. (2023, June). Toward a System that Curates and Documents Resources for GeT Instruction. *GeT: The News!*, 4(3). <https://qa.gripumich.org/v4-i3-sp2023/#toward-a-system-that-curates-and-documents-resources-for-get-instruction>



Mathematics Instructors at All Levels are Part of the Same Team

by Michele Macke

Early in my involvement with the GeT ESLO group, I asked about the end goal of the group. I asked this question because I suspected that my goal was different from some of the other members of the group. Sure, I agreed that the Geometry for Teachers courses needed guidelines to ensure that the course was preparing future teachers to be successful Geometry teachers, but there were many more reasons that I wanted to be part of the project.

Too often, there is a disconnect between college education courses and what is actually occurring at the secondary level. Conversely, high school Geometry teachers need to know what math deficiencies college instructors are seeing in their undergraduate students. Without any interaction between these groups there can really be no concrete improvement in the

preparation of future math teachers. This project is a great example of how that interaction can work to better prepare future math teachers, let current teachers know what college level instructors think are the important topics for high school courses, and can help college level instructors improve the focus of their course.

The discussions that have occurred in the ESLO group have illuminated this, and while the overarching goal is to give feedback to the GeT SLO authors, there are powerful conversations taking place where college level instructors, as well as high school instructors, get to voice concerns that they have about the preparedness of these future students entering college, as well as leaving college. These conversations are most assuredly going back to all the participants' institutions in a variety of ways. For example, there were some intense exchanges surrounding the use of Dynamic Geometry software such as Geogebra. The perception was that this software is being used as a substitute for compass and straightedge instruction, instead of being used as a tool to further students' abilities to make conjectures. High school teachers in the trenches see a curriculum that mirrors these tensions. Often curriculum developers are including the use of this software to "check off" a box about their product. In those instances, the software is being used to illustrate concepts instead of making students dig deep and use the software to make and justify their own hypothesis. Good teachers recognize this, using the software in more meaningful ways and recognizing that this needs to be an explicit point in the SLO. This conversation is a small example of the power of these discussions between the two levels of educators. Improving this SLO might lead to an improvement in high school geometry instruction by making future teachers aware of the difference between superficial use of these construction tools and the real power they hold to ignite interest and excitement in the high school classroom.


I have another more personal reason for my involvement in the ESLO group. Being involved in collaboration with mathematicians in different levels of education validates my worth as an educator. The media has not been kind to public school educators over the last ten years, but I leave the meetings more optimistic about the future of education. The conversations that occur in the group reveal a passion for math education across a broad swath of educators that is invigorating and satisfying. It is not unlike those moments in the classroom when a struggling student suddenly has a breakthrough and allows the teacher to share in their momentary exhilaration. Those moments are part of our pay as educators and cannot really be explained outside the field of education.

I worry about the future of my profession. Young teachers who survived the Covid education crisis are worn down, and there are not as many student teachers entering the field behind them. We need to nurture them and allow them to see that they are part of something bigger. These kinds of collaborations can do that. New math teachers are often reluctant to teach geometry because they do not feel as prepared for this course as they do the Algebra based courses. The beauty of this project is that improving GeT courses will make future geometry teachers more confident when they enter the geometry classroom as first year teachers, and this alone will help retain new teachers.

I would like this project to be a model for cross level collaboration in math education and allow more of the new teachers access to these. They could use some validation too.

Suggested Citation

Macke, M. (2023, June). Mathematics Instructors at All Levels are Part of the Same Team. GeT: The News!, 4(3).
<https://qa.gripumich.org/v4-i3-sp2023/#mathematics-instructors-at-all-levels-are-part-of-the-same-team>



Rethinking Geometric Constructions Through a Makerspace: A Kinetic Sculpture Project

by Soobin Jeon

Introduction

Makerspaces, varying in shape and size, serve as spaces where students convene to create, invent, tinker, explore, and discover using a diverse range of tools and materials. Makerspaces are natural places for developing mathematical arguments and mathematical models, where geometric assumptions are supported and real-world complexities arise. Drawing inspiration from an eighth grade makerspace project called Kinetic Sculpture, I illustrate the ways in which construction within makerspaces offer

mathematics teachers ample opportunities to foster students' geometric thinking across various domains. This article presents tasks centered around the construction of kinetic sculptures, shedding light on the geometric properties and assumptions that can be explored through students' physical creations. Exploring the geometric properties inherent in the design of kinetic sculptures presents valuable opportunities to not only justify the correctness of Euclidean construction (SLO 8), but also encourage the investigation of geometric properties spanning multiple dimensions and adapt to diverse opportunities and constraints (e.g., materials, mobility, and assembling) often encountered in makerspaces.

Makerspaces

Constructivism speaks to the value of the learner constructing their own knowledge based on experiences and interactions with the real world (Binguier & Piaget, 1980). The learning happens where the learner is positioned to actively construct meaningful, physical objects for the purposes of sharing playful and useful creations with the world (Hansen et al., 2019; Papert & Harel, 1991). In makerspaces, the focus is not solely on the types of tools and materials but rather on the act of making itself. Unlike traditional approaches in geometric constructions that often rely on straightedge and compass constructions, makerspaces offer a broader range of possibilities. These spaces provide a platform for learners to explore and express their creativity, utilizing various tools and materials to bring their mathematical constructions to life, thus fostering a deeper understanding of mathematical concepts through tangible and relatable constructions.

Makerspaces naturally allow students to translate between the physical world and its representation using geometric models through drawing or design. At the same time, students learn that adding a strand of wire to a sculpture cannot be contained within the strictest geometrical definitions of a line, an infinitely long object with no depth or curvature. No physical circle made by nature or human can be as perfect as its definition and set of written properties, such as having a circumference consisting of equidistant points from the center. Students realize that constructions from the 2D to 3D spaces involve different mathematical processes. The exploration in a makerspace can allow students to appreciate the limitations and variations that exist between the precise geometric definitions and the physical manifestations of objects, such as a clock, which may deviate from their ideal form that students are used to in school mathematics.

Bridging the Gap between Mathematics and Makerspaces

Despite the potential benefits, there is a lack of support for students in recognizing how the construction of artifacts in makerspaces can enhance their learning of mathematics. Collaboration between makerspace or design teachers and mathematics teachers is often limited. One challenge seems to be the unpreparedness of mathematics teachers in effectively planning and communicating ways for their students to do mathematics in the makerspace. Makerspace teachers often support other disciplinary teachers in integrating their subjects into the makerspace environment. In conversation with the makerspace teacher who developed the Kinetic Sculpture project, it was surprising to find out that among all disciplinary teachers, mathematics teachers were found to be the least likely to make use of the makerspace. It is interesting to note that in makerspace or design projects involving mathematical construction, the responsibility of communicating geometric properties to students often falls on the makerspace teacher. Additionally, the makerspace teacher revealed that opportunities for students to reflect on their physical constructions tend to be missed or overlooked. This presents a significant opportunity for mathematics teachers to design impactful learning experiences that integrate geometry and physical artifacts in makerspaces. By incorporating geometric constructions and properties into the context of a Kinetic Sculpture makerspace project, I aim to demonstrate the potential for mathematics teachers to seize these opportunities and facilitate meaningful geometry learning for their students.

Kinetic Sculpture Construction

In the eighth grade makerspace project titled "Kinetic Sculpture," students engaged in constructing sculptures that express themselves through the use of ratios. Students strove to convey a harmonious, balanced, and aesthetically appealing composition while expressing their individual messages. Taking inspiration from the renowned American sculptor Alexander Calder, students were taught how his mobile kinetic sculptures achieved balance by distributing force evenly through their linkages, remaining sometimes still but never static. The goal of this project was for students to successfully create a kinetic sculpture capable of spinning. The tasks to reach this goal were:

1. Use precise measurement and proportions to design a kinetic sculpture that is balanced in its structure (e.g., symmetry, equality, congruence).

2. Compare the geometric properties underlying the 2D construction and identify any properties that are not upheld in the 3D construction. How do these properties contribute to the sculpture's construction and spinning motion?

In these tasks, students applied mathematical principles related to measurement, proportion, balance, symmetry, and geometric properties to create a functioning kinetic sculpture that spins. They critically assessed the alignment between their design intentions and the realized

construction, highlighting any geometric properties that may impact the sculpture's performance. In particular, when the students constructed the 3D sculpture, they put together various layers of the sculpture (e.g., Figure 2a) to connect them at the center or axle, allowing for the spinning motion. The completed kinetic sculptures below (Figures 2b, 3, 4, 5a, 6, 7) were developed by students who participated in the Kinetic Sculpture project. Presenting these geometric constructions in the mathematics classroom allowed opportunities for students to identify geometric properties in their construction and notice the different properties that exist in the 2D and 3D construction and occur when the sculpture is mobile. In this article, I discuss how the completed kinetic sculptures can be brought back to the mathematics classroom for the mathematics teacher to verify these geometric properties work.



Figure 1 Sample of students' kinetic sculptures

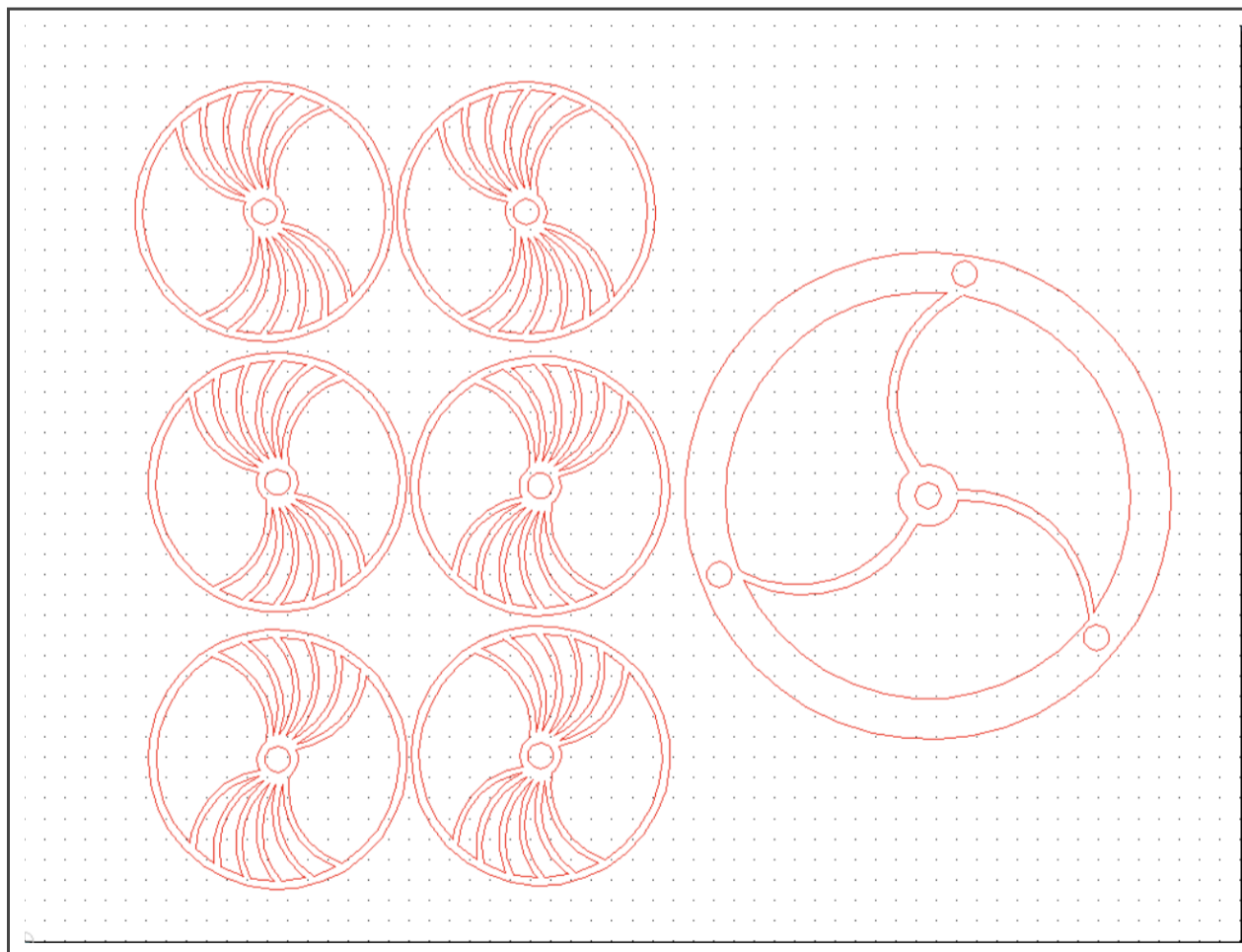


Figure 2a Figure 2b



Figure 3 Figure 4

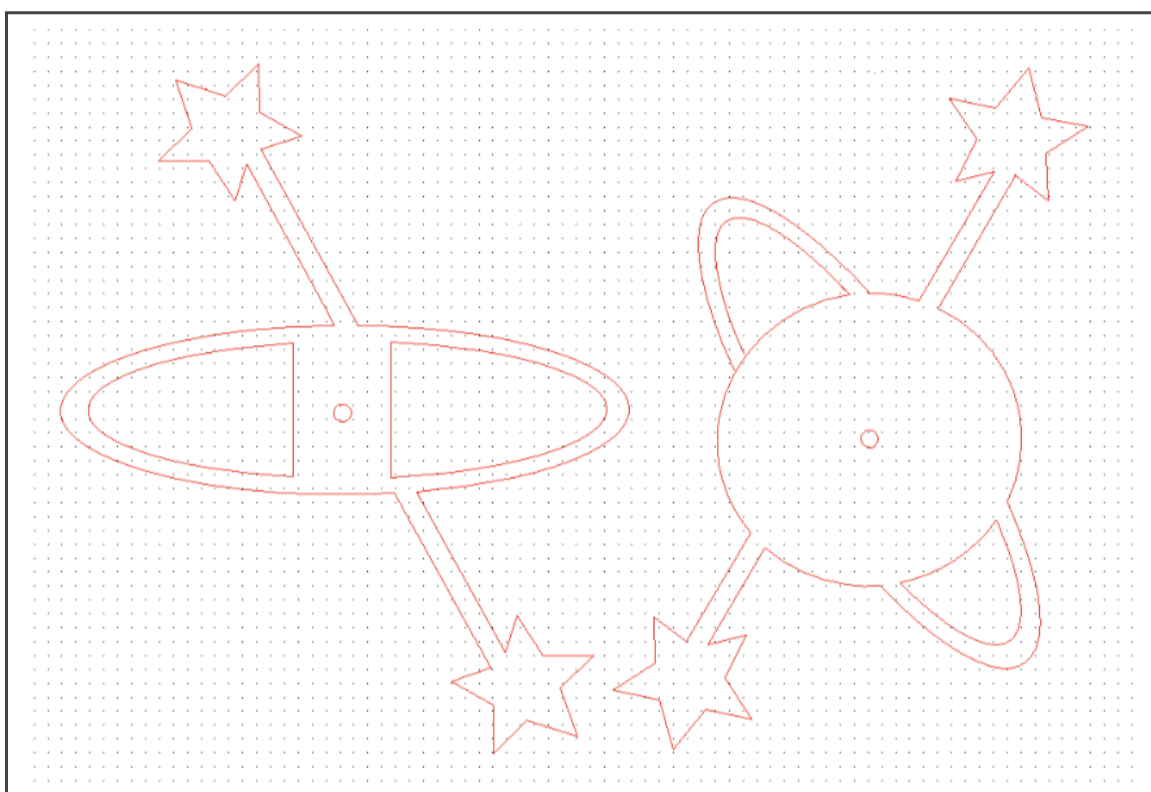


Figure 5a Figure 5b

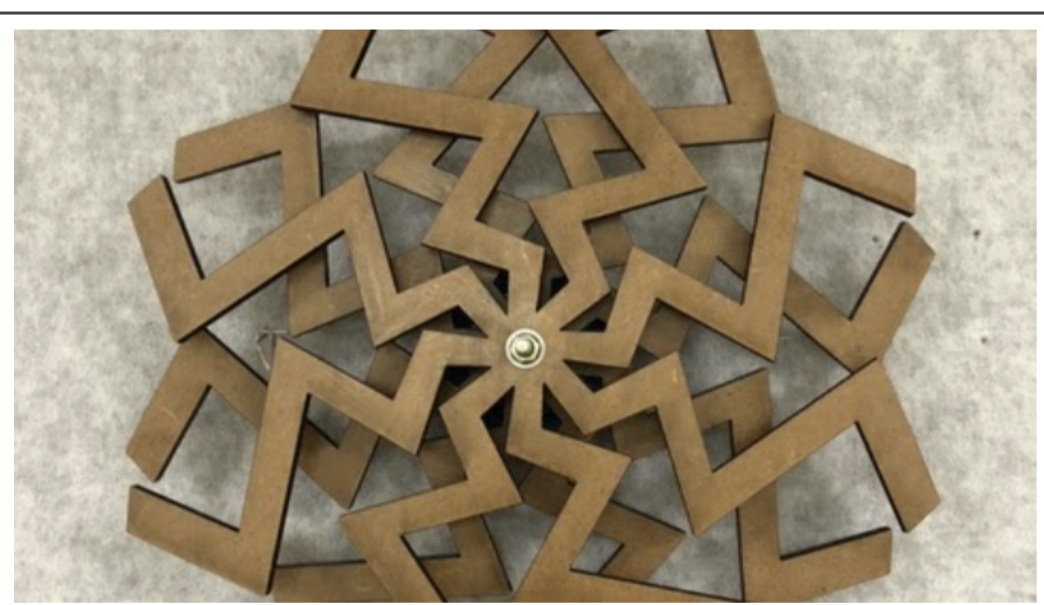
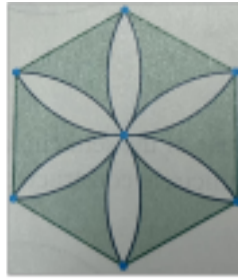


Figure 6 Figure 7

A significant number of kinetic sculptures prominently feature circular elements. Some of these sculptures incorporate circular components characterized by a central point and curved spokes that extend outward in various directions, converging at a centralized location within the circle (Figures 3 and 4). In Figure 4, the design of each layer is made up of five curved spokes, and these spokes are designed to be congruent. The mathematics teacher could ask the students how they might figure out mathematically whether they are congruent. These curved spokes are constrained within the circle, and their congruence can be described using various geometric properties, such as the arc or sector of a circle. Students might notice that these curved spokes are like arcs of a circle. In Figure 3, the design of the purple layer has six petals while the white layer has eight petals. If a hexagon or octagon is drawn where the end of each congruent petal is the vertex of the polygon, are these polygons regular? In particular, in a regular hexagon, each petal is made of the arcs of congruent circles whose centers are the vertices of the hexagon. All the arcs

intersect at the center of the original circle or hexagon. The same property does not hold for a regular octagon but it would be

interesting to see what other properties can be discovered.



Figures 6 and 7 also incorporate spoke-like shapes that converge at the center and extend outwards but do not reach a rim. In Figure 7, describing the jagged lines is not a straightforward task, as they possess unique characteristics. These characteristics include increasing line segments separated by jagged points. An intriguing investigation involves characterizing each line segment based on its length, direction, and angle that maximize the jaggedness without causing intersections with the other spokes. The kinetic sculptures can also be described with proportions and ratios. In particular, the concept of the Golden Ratio can be used to describe the completed sculptures. Many patterns observed in nature, such as the arrangement of leaves or petals around a stem or center, follow spiral structures that can be described using the Golden Ratio. The number of spirals, the count of shapes, or measurements of neighboring line segments in one direction often align with Fibonacci numbers (a sequence in which each number is the sum of the two preceding ones). Determining whether the features of the kinetic sculptures

adhere to the Golden Ratio would justify the balance of geometric shapes. For instance, it may provide a rationale for the dimensions of the distorted quadrilaterals in Figure 6, further enhancing our understanding of the sculptures' geometric composition.

Up to this point, I have explored geometric properties that describe each layer of a kinetic sculpture. However, the completed kinetic sculpture allows for reflection on what needs to be considered when transitioning from the 2D design to the 3D construction, delving into real-world applications. In makerspaces and professional contexts like architecture, carpentry, or quilting, factors such as material properties, construction techniques, measurement errors, and tool limitations introduce variations that no longer prioritize the idealized geometric properties defined by Euclidean geometry. In the context of the kinetic sculpture project, understanding and utilizing geometric properties become crucial for ensuring proper alignment and functionality, particularly when dealing with a concentric axle and multiple layers.

One key consideration is the placement of the axle, which greatly impacts the functionality of the sculpture. Achieving concentricity, where the sculpture's layers connect at the center, is essential for promoting balanced rotation and minimizing vibrations. When the layers within a kinetic sculpture are identical (Figure 3) or mirror images of each other (Figures 4, 6, 7), establishing concentricity is relatively straightforward. However, when different layers are involved, additional considerations arise. For example, in the construction of the kinetic sculpture depicted in Figure 5b, two distinct layers are utilized (Figure 5a). Finding the center of the oval becomes essential for determining the placement of the first layer (left image, Figure 5a), while locating the center of the circle becomes crucial for positioning the second layer (right image, Figure 5b). This example shows the practical aspects of working with non-ideal shapes and the need to adapt geometric concepts to accommodate these variations.

Figure 2b presents another important and practical consideration when assembling the layers for the 3D construction. It is crucial to ensure that the larger circular layer (right image, Figure 2a) has a circumference with a width sufficient to accommodate axles that align with the centers of the smaller circular layers (left images, Figure 2a). This consideration highlights the geometric relationship between the layers and the need for precise alignment to maintain the structural integrity and functionality of the kinetic sculpture. By ensuring that the axles fit with the centers of the smaller circular layers, the rotational movement of the sculpture is secure and balanced. The weight of the sculpture is an additional dimension in the construction process. In Figure 5b, for example, the stars extend outward from the more stable center of the kinetic sculpture. Therefore, when constructing the sculpture, it is essential to consider the materials' properties to ensure that the structure is robust enough to withstand the intended spinning movement. By carefully selecting materials with appropriate strength and durability, the construction can support the weight of the sculpture and maintain its structure.

Finally, spinning the kinetic sculptures offers a unique perspective to explore and appreciate their geometric properties. In addition to the constructed sculptures, students took videos of their kinetic sculpture spinning and what these videos capture are invaluable for geometric analysis. The dynamic nature of spinning allows for the observation of patterns,

shapes, and symmetries that may not be readily apparent when the objects are stationary. The kinetic sculpture may exhibit rotational symmetry as the kinetic sculpture repeatedly displays the same pattern or shape at regular intervals. This symmetry becomes more pronounced during rotation, revealing the underlying structure and balance within the object. In addition, the

concept of kinetic symmetry can arise, where an object appears symmetrical when in motion but reveals asymmetry when at rest. This dynamic interplay between symmetry and asymmetry adds depth and complexity to the understanding of geometric properties. For example, spinning Figure 4 reveals moments when the curved spokes create flower-like petal shapes, providing a visual confirmation of the design intention. Spinning Figure 2b provides a captivating opportunity to witness the intersections between the smaller circles and the circumference of the larger circle at multiple points. By adjusting the spinning parameters of the larger circle, such as its rotational speed (which can be simulated by increasing or decreasing the speed of the video) or direction (which can be simulated by fast-forwarding or rewinding the video), students can observe how these factors might cause the smaller circles to appear more tightly clustered or spread out along the circumference. This could lead to different observable patterns, such as spirals or complex curvatures, as the smaller circles interact with the rotating larger circle. As such, the construction of 3D kinetic sculptures that spin can offer interesting insights into geometric properties. While there may be deviations from the idealized or intended geometric decisions, the real and dynamic nature of these sculptures enriches our understanding of geometry in valuable ways.

Conclusion and Implications

In conclusion, the geometric constructions in makerspaces involve a delicate balance between idealized geometry and practical considerations. While deviations from idealized concepts are inevitable, the fundamental principles of geometry guide a successful construction. Engaging with the construction in the various domains, such as 2D, 3D, static, and mobile, provides valuable insights into the adaptability and versatility of geometry. Practical considerations highlight the importance of incorporating real-world constraints and variations into geometric construction processes. By working with the variations introduced by material properties, construction techniques, and measurement limitations, students engaging in the Kinetic Sculpture project gain a deeper understanding of the role geometry plays in real-world applications and the need to adapt geometric principles to achieve functional, balanced, and aesthetically pleasing end products.

Given the current lack of collaboration between mathematics and makerspaces, there is a need to enhance the preparation of future mathematics teachers, providing them with the necessary skills to develop meaningful geometric tasks that seamlessly integrate geometry with students' physical creations. The tasks described in this article can be undertaken by future mathematics teachers, enabling them to explore geometric constructions beyond the confines of the mathematics classroom and encouraging the utilization of available resources or artifacts at school, which they may have been hesitant to employ otherwise. Even without access to makerspace resources, future teachers can leverage images or video recordings of kinetic sculptures, which offer an engaging method to convey geometric concepts and identify geometric properties. By embracing an interdisciplinary approach to teaching, future mathematics teachers will become better equipped to establish connections between various fields like architecture, engineering, and prototyping, thereby developing a more holistic understanding of constructions rooted in geometry.

By incorporating hypothetical mathematical tasks that simulate the construction process, mathematics teachers can significantly enhance students' understanding of geometry within various learning contexts. These tasks provide avenues for exploring the intricacies of geometric construction in makerspaces, where physical limitations may constrain actual construction. The constructions in geometry require a rigorous understanding and application of geometric principles. Success lies not only in the physical construction but also in the ability to articulate the geometric properties that exist within the constructions. Engaging with such tasks provides a deeper connection with geometry, fostering analytical, creative, and systematic thinking among students. As students navigate the construction process, transitioning from 2D to 3D and from static to mobile structures, they gain an appreciation for the importance of precision, adaptability, and the interplay between idealized geometry and practical considerations. This preparation aims to equip students for future endeavors where they may encounter complex geometric problems, requiring them to make informed decisions based on both mathematical principles and real-world opportunities.

Resources

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Suggested Citation

Jeon, S. (2023, June). Rethinking Geometric Constructions Through a Makerspace: A Kinetic Sculpture Project. *GeT: The News!*, 4(3). <https://qa.gripumich.org/v4-i3-sp2023/#rethinking-geometric-constructions-through-a-makerspace-a-kinetic-sculpture-project>



The value of contributing to the development of an edited volume: How I decided my participation matters

by Amanda Brown

Over the past few months, many of you have contributed chapters to an edited volume that the GeT:A Pencil Community will soon be submitting to the MAA. Some of you are still in the process of wrapping up a chapter. In the next month or so, the co-editorial team will be asking many of you, whether you contributed a chapter or not, to pitch in and provide reviews of those chapters. We certainly know how to keep you busy! When it comes to my own motivation for working on this project, including helping to write a chapter and, undoubtedly, reviewing chapters, it helps me to recall the reasons why I took on this project in the first place.

In this newsletter article, I will share some of the reasons why I initially decided to participate in the development of an edited volume and why I continue to believe that the work we are doing can have a lasting impact on both individual authors and the collective field focused on understanding and improving the undergraduate geometry course for teachers. My hope is that if you are lacking motivation to finish up that chapter (we've all been there) or engage with the upcoming review process (which is not uncommon either), the reasons I outline here will help you reflect on your own reasons for contributing to the development of this volume.

Oh, and for those of you who are just now hearing about this project, the edited volume will focus on providing readers with resources such as commentary, instructional materials, and ideas for improving the undergraduate geometry course for teachers.

One reason I decided to get involved with the development of this edited volume is because of the opportunity for the GeT: a Pencil community to engage in synergistic collaboration with others in the field. By joining forces with a diverse group of contributors, each of us will have the opportunity for collaboration with other researchers and writers. By working together with a diverse group of individuals, we can tap into a collective pool of knowledge, expertise, and perspectives. This collaboration fosters a spirit of synergy, allowing us to build upon one another's ideas, challenge assumptions, and explore new dimensions of scholarship related to the undergraduate geometry course for teachers. The result is a richer, more comprehensive body of work that surpasses the limitations of individual contributions.

Another reason I decided to get involved with the development of this edited volume is that I knew these kinds of opportunities often allow contributors to amplify the impact of their own scholarship and perspectives. By being part of a collective work, each of us can gain visibility and recognition for our work within a larger context. As editors, our hope is that through careful curation and organization of chapters, we will ensure that each contribution complements and enhances the others, creating a cohesive and powerful whole that can help ensure greater reach for our individual work. This amplification of individual contributions elevates the reach and influence of authors, enabling their work to resonate with a broader audience and make a more significant impact.

Additionally, I decided to get involved because work on edited collections often creates valuable opportunities for networking and professional growth. Collaborating with fellow authors and engaging with the editors has a way of fostering connections and relationships, something the GeT: a Pencil community has valued from the beginning. When considering whether I should get involved in this edited volume, I knew the opportunity to deepen and expand these connections both within the community and the field at large was too good to pass up. Even now, I am seeing ways the upcoming interactions around the chapters in this volume can lead to new collaborations, mentorship possibilities, and exposure to different areas of scholarship and perspectives. Furthermore, being part of an edited collection enhances an author's professional portfolio, showcasing their ability to contribute to collective endeavors and demonstrating their commitment to advancing scholarship in our individual fields.

A fourth reason why I decided to support the development of this edited volume was my awareness that an edited collection offers contributors a platform for intellectual engagement and inspiration. Interacting with diverse perspectives, exploring new ideas, and immersing oneself in the collective knowledge of the contributors can spark creativity and open new avenues of thought. The process of refining and adapting individual work to fit within the larger framework of the collection challenges authors to think critically and expand their intellectual horizons. The act of reading and writing educative reviews, as well as responding to reviewer comments (especially those with different perspectives), has been an incredible source of intellectual stimulation in my career. It has fostered personal growth, fueled my passion for scholarship, and inspired me to push the boundaries of my own knowledge and expertise. My hope is that this outcome will be the same for you as you set yourself to the tasks ahead related to writing and reading reviews of the chapters submitted to this compilation.

One of the most rewarding aspects of contributing to the development of an edited collection is the opportunity to be part of a greater cause. In fact, when deciding whether or not my participation in this particular edited volume was worth the time investment, this greater cause to which we endeavor solidified my decision. From the beginning of the project, Pat and I have advocated for one particular cause: improving the capacity for teaching high school geometry. This edited volume focuses on a subject that, in my opinion, has a good chance of making progress on that cause by providing resources, addressing challenges, and advancing scholarship related to leveraging the recently proposed Student Learning Objectives (SLOs) for the undergraduate geometry course for teachers. By participating in the development of this volume, whether as an author or reviewer, I firmly believe individuals will have the chance to actively contribute to that greater cause.

Throughout my participation in this book project, a second worthwhile cause has become increasingly apparent: advancing the means for undergraduate mathematics instructors to see and intervene in their own instructional practices in order to collectively improve the capacity for teaching undergraduate mathematics courses for teachers. When I mention “advancing the means,” I refer to the belief that the development of this volume plays a crucial role in what I perceive to be a novel and emergent way of working together to support instructors of undergraduate geometry courses in taking a central role in improving their own practice.

For me, the development and proposal of the SLOs for guiding GeT courses represent the first step in that process. Why? Because that development happened through an instructor-led effort where the community of instructors was open to contributions from any instructor interested in participating over the course of 2+ years in the writing of the first version of the SLOs.

However, that alone was not enough. The willingness of the authors of those SLOs to open their work for critique through the proposal of this book was an important second step not to be missed. It is so common to want to protect what we endeavor in. In my opinion, the group’s willingness to pick a different approach—to maintain an open stance toward the perspectives of newcomers—is one of the most beautiful, brave, and democratic things I have witnessed in my professional life.

Finally, a third crucial step in this new way of working is the willingness of the broader community to respond to the call for proposals for this volume centered on those SLOs. The number of submissions we received for this book took us by surprise. When we started, we hoped we would have enough contributions to make a book, but we were not sure because academics often find it difficult to slow down long enough to read one another’s work carefully enough to build off of it. Now we have so many chapter contributions that we feel a little strange calling this thing a book anymore; it feels more like a volume!

In this way, we are beginning to wonder if this volume is more than a volume, or if it is not playing its part in revealing a novel way forward for supporting meaningful collaboration among university instructors of mathematics. To that end, I now see how the time I have contributed towards the development of this book is part of something much bigger than I initially anticipated. Specifically, I see the potential for the development of this volume to serve as part of a collective effort to generate scholarship, inspire change, and contribute to a process of improvement that can serve as a roadmap for future efforts to enhance undergraduate mathematics.

The satisfaction and fulfillment that have come from this last possibility—knowing that I am contributing to a meaningful endeavor that may help us rethink the way we work together—along with the other benefits I outlined herein, provide me with a sense of purpose that motivates me to deepen and further my own professional journey. It also motivates me to complete my chapter (yes, I am among those who needed an extension). My hope is that something I have shared connects with your “why” and helps to motivate you to power through the reviews I will soon be sending to your mailbox! Wishing you a productive and relaxing summer.

Suggested Citation

Brown, A. (2023, June). The value of contributing to the development of an edited volume: How I decided my participation matters. GeT: The News!, 4(3). <https://qa.gripumich.org/v4-i3-sp2023/#the-value-of-contributing-to-the-development-of-an-edited-volume:-how-i-decided-my-participation-matters>



Transformation Group Update Spring 2023

by Julia St.Goar

This summer, transformation meetings will focus on the on-going lesson study (Boyce et. al., 2023), where an evolving lesson involving Adinkra symbols from Ghana (Eglash, 2021; Willis, 1998) are used to reinforce several SLOs including SLO 10 (Transformations), SLO 5 (Definitions), and SLO 2 (Critique Reasoning). One possible future direction regarding the lesson study is to focus on student thinking, both about the SLOs and about culturally responsive teaching (Abdulrahim & Orosco, 2020; Matthews et al., 2022). We are interested in having new members join to have a “fresh set of eyes” on our lesson study as well as potentially introducing new lesson studies. These meetings over the summer will be facilitated by Steve Boyce and will take place every other Wednesday at 11am (EDT).

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Suggested Citation

St.Goar, J. (2023, June). Transformation Group Update Spring 2023. GeT: The News!, 4(3). <https://qa.gripumich.org/v4-i3-sp2023/#transformation-group-update-spring-2023>



Update on the ESLO Working Group

by Mara P. Markinson

The ESLO working group is a cooperative group of high school geometry teachers, university GeT instructors who are mathematics teacher educators, and university GeT instructors who are pure or applied mathematicians. Our group was founded in fall of 2022 and has continued to meet twice monthly this semester. Our charge over this academic year was to come together as a subset of unique stakeholders in the GeT: A Pencil community to share our opinions and feedback on the first published draft of the Student Learning Objectives (SLOs hereafter).

At each meeting, we focus on one SLO. Each member of the group shares their reactions to parts of the SLO text, which typically includes anecdotes from teaching experience or research. Together, we contemplate the degree to which the SLO captures what our collective experiences have taught us and what we would hope to see in a GeT course. We begin by looking at the parts of each SLO that resonate with us most and then formulate ideas for edits to the text which may make certain ideas clearer to different readers: GeT instructors, GeT students, or high school geometry teachers. This semester, the ESLO group also met in smaller groups of 3 members to craft summaries of the group's feedback for each SLO. These summaries were then posted to the GeT: A Pencil

forum (<https://getapencil.org/community/>). We hope that in this way, we can not only celebrate the work of the authoring team and provide useful feedback to them, but also make others interested in GeT instruction aware of this guiding document and encourage them to join the conversation. By bringing together instructors of geometry at different levels, the ESLO group has put the SLOs into the hands of many who plan to disseminate the guidance and insight that the SLOs provide.

Suggested Citation

Markinson, M. (2023, June). Update on the ESLO Working Group GeT: The News!, 4(3). <https://qa.gripumich.org/v4-i3-sp2023/#update-on-the-eslo-working-group>

Teaching GeT Working Group Update

by Nathaniel Miller

Members of the Teaching GeT Working Group have been working tirelessly to finish their submissions to the GeT course book. Now that they are (mostly) all submitted, the group will be taking the summer off! We will resume meeting in the fall. Anyone interested is invited to join us then!

Member Highlight: Scott Acre

Four questions with Scot Acre, Mathematics Teacher at the Macomb Mathematics Science Technology Center

- **How did you learn the geometry you teach?**

On the job, memories from high school, attending conferences, reading books, belonging to professional organizations.

- **What do you enjoy about teaching geometry?**

I love the visual nature of the subject. I love how Geometry began as a way to figure out what was going on in the world. I love how there are multiple methods to accomplish a task/concept/standard.

- **Who are your students?**

I teach at a magnet STEM program in Warren, MI. (Macomb Mathematics Science Technology Center) As such, my students are the best and brightest in our part of the county. Many are perfectionistic, motivated, dedicated students. I love the students that I get a chance to work with each and every year!

- **What are you most interested in learning/achieving through participating with the GeT: A Pencil community?**

Well I have already learned so much. I am loving the vertical alignment that is occurring between HS teachers and College Professors. I marvel at what a talented, intelligent group of people that has been gathered. I hope that we all achieve something that becomes a golden standard for teaching and learning.

- **What is your favorite book you have read in the last few years?**

Talking to Strangers by Malcolm Gladwell.



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GeT Support

Sponsored by NSF DUE-1725837. All opinions are those of the authors and do not necessarily represent the views of the National Science Foundation or the University of Michigan.

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Get Support is housed in the GRIP Lab at the University of Michigan