Liberal Studies BA with a Concentration in Science, Mathematics, Technology and Art or LIBA STEAM proposal

Proposal author: *Norma Boakes*

Proposal collaborators:

- Stockton Teacher Education Program faculty
- *Doug Harvey*- Associate Professor of Instructional Technology, MAIT Director
- *Aakash Taneja*- Professor of Computer Science and Information Systems, Program Coordinator
- *Chia-Lin Wu*- Professor of Mathematics, Program Coordinator
- *Wendel White*- Distinguished Professor of Art, Program Coordinator
- *Tara Luke*- Professor of Biology, Stockton STEM Collaborative faculty representative

Overview

Definition

The Liberal Studies BA with a concentration in science, mathematics, technology and art (LIBA STEAM) is a proposed concentration that joins existing concentrations designed for students seeking a well-rounded liberal studies education while earning *elementary and middle school teacher certification*. The two approved LIBA concentrations available to Stockton students include the Liberal Arts with Elementary Education Concentration (LIBA ELEM) and Liberal Arts with Language Arts and Social Studies (LIBA LASS). The LIBA ELEM offers study in the four major content areas taught in K-12 settings (language arts, mathematics, science and social studies). The LIBA LASS also covers the four major content areas but has more coursework in language arts and social studies for those wishing to target middle school specializations in these areas. The proposed LIBA STEAM is meant to offer a third option to students that will cover the four major content areas in K-8 settings but also have a focus in the areas of mathematics, science and their connections to technology and art.

Rationale and goals

The main rationale for proposing the new concentration (STEAM) is because currently there is no degree concentration in LIBA designed for students with an interest in teaching middle school mathematics or science. The LIBA ELEM is the most general option offering a blend of all content areas to earn elementary certification (K-6). The LIBA LASS is more specialized offering more coursework in social studies and language arts so a student can also earn middle school specializations (7-8) along with their elementary teacher certification. However, there is no designated concentration for those students with an interest in teaching middle school science and/or math. Currently, a student that has a direct interest in teaching mathematics or science must major in the subject along with an education concentration. This is suitable for a student seeking secondary certification (6-12) but does not necessarily address the student wishing to teach only middle school age students in mathematics and/or science. The full major also does not provide the broader knowledge of ALL content areas needed for elementary teacher certification.

The proposed concentration also stems from a review of program data. One set of data reviewed was enrollment in STEM/STEAM related areas leading to teacher certification from the Tableau system. See Table 1. Notice the significant interest in LIBA options (278) compared to pure majors like mathematics (62) or science (32). Students in LIBA concentrations will earn elementary teacher certification with possible middle school specializations. While there is a concentration that offers a specialization in language arts and social studies (LIBA LASS), there is no equivalent concentration for an interest in middle school math and/or science.

Table 1. Enrollments by education concentration in elementary, math & science areas

	Fall 2016	Fall 2017
LIBA ELEM	271	248
LIBA LASS	44	30
MATH w/EDUC	67	62
BIOL w/EDUC	22	18
ENVL w/EDUC	4	5
MARS w/EDUC	8	9

An additional set of data worthy of mention is provided by the state of New Jersey. Each year a summary report of program completers is provided for all teacher preparation programs (New Jersey Department of Education 1, n.d.). In Stockton's most recent 2017 Educational Preparation Provider Report, it was found that:

- Our largest population of graduates seek elementary school teacher certification (71 completers) compared to other areas like mathematics (6 completers) and science (4 completers)

- Graduates with a middle school mathematics certification (11 completers) had a 10% higher rate of employment than those students who only sought elementary certification (73% versus 63%)
- Only 4 completers sought middle school science specialization along with their elementary certification (*see hyperlink for more details*)

The goal of this proposed concentration would be to address the gap in teacher certification options offered at Stockton.

STEAM vs. STEM

Important to this proposed concentration is the intentional choice to make the LIBA concentration STEAM vs. STEM. The concept of STEM is a well-established phrase denoting the blending of disciplines including science, mathematics and technology. National job market analysis supports this integration with today's careers requiring a different style worker able to innovate and create solutions for large global challenges that cross discipline boundaries (US Department of Education, 2016). However, the inclusion of art, referred to as STEAM, has only gained popularity in the past decade seeking to add the creativity, planning and design thinking that is needed for innovation (Chand, 2014; Jolly, 2014; Eger, 2011). To understand the connection of art to the branches of science, math and technology consider what the practice invokes beyond the direct skills taught such as drawing pencil sketches or building a sculpture. Instruction requires learners to create designs from ideas, critique others work, and seek to find new approaches to existing techniques. These skills are beneficial since they supports the act of inquiry and problem solving found within STEM (Riley, 2017). In many areas of art, other disciplines are also part of the artistic process. Examples of this are found within Stockton's curriculum such as ARTV 3674 3D *Modelin*g that utilized technology for 3D modeling of art or ARTV 3674 *Sculpture Geometry and Design* that examines geometry within art design. Wendel White, a distinguished professor of art at Stockton and ARTV course instructor at Stockton describes the connection:

> "*Our core courses include the essential elements necessary for any STEM discipline that requires or utilizes the translation of three-dimensional objects and spaces onto two-dimensional surfaces. These course develop student skills and understanding of proportions, scale, perspective, shape, measuring, the dynamics of light, surface and more. None of these skills, however acquired can be elimated from STEM curriculum. Painting builds on the principles of drawing while adding knowledge of color theory and color mixing. Sculpture and 3D Design support the concepts of structural and spacial understanding" (White, 2017)*

In addition to Stockton coursework, a workshop held on Stockton campus called Stockton STEAM exemplifies the value of art in STEM. This two-day event held in November 2016 sponsored by Stockton NAMS explored the synergy between arts and science featuring "examples of art/science collaborations, and present methods for cross-disciplinary engagement, opening conversations between faculty and students in STEM disciplines with the Arts and Humanities" (Stockton University, 2016). The lead speaker, Dr. Kim Landsbergern, an environmental scientist, highlighted the importance of collaboration between science and art. Specific skills like to "wonder" are inherent in both art and science and seek to answer big questions about the world (Landsbergern, 2016). (*See appendices for full presentation and Stockton STEAM event*.) Evidence found in Stockton's own practices and curriculum is the same kind of work done at the national level that sees the arts as a gateway to build creative, innovative minds capable of solving critical issues of today (Hendricks, 2016; Hertz, 2016: Land, 2013; Tarnoff, 2010). As a whole, the body of research on STEAM supports the interdisciplinary connections and explorations that the proposed LIBA STEAM degree can provide our students. For further readings on the topic and support of the concept, please consult the references provided at the conclusion of the proposal.

Needs Assessment

National & state trends

The concept of study in STEM/STEAM approaches is well documented at the national level. The most comprehensive source is the *STEM 2026: A Vision for Innovation in STEM Education* report sponsored by the US Department of Education (2016). This report speaks directly to the need to support study in math, science and technology learning in K-12 to serve the growing need for workers in STEM-related careers. Interdisciplinary study is also noted as critical in developing the kind of thinking and creativity in learners needed to tackle global challenges. The call for this type of instruction requires qualified teachers to teach in these areas. However, the 2017 Teacher Shortage Area report by the US Department of Education identifies shortages of teachers in both mathematics and science at the middle school level in several states including New Jersey (2017).

At the suggestion of the Academic Program & Planning Committee, data from Hanover Research, an academic consulting firm partnered with Stockton, was also reviewed to determine trends in areas linked to STEAM study. Two distinct categories were available including science teacher education and mathematics teacher education. The labor market projection report for both mathematics and science teachers illustrates a continued need for science and mathematics teachers at the national, regional and state level. (See appendices for the full report.) Data on completions of study at the undergraduate level was similar with a decline in completions seen overall at state and national level (ranging from 2011-2015).

Student interest

Student interest in elementary certification with middle school specialization is visible through LIBA paths (shown in Table 1). Among them many students (44 & 30 respectively) elected the LIBA LASS specialized path offering them middle school specializations. To give you a sense of the significance of this enrollment, consider the number of students found in any of our paths leading to secondary certification (ie. 61 in HIST, 50 in LITT, 42 in sciences, and 62 in MATH). With this interest in a more specialized concentration, students would likely opt for STEAM concentration if offered. There is also evidence in interest based on enrollments in courses that link to the study of math and science. The Stockton courses shown in Table 2 offer the closest match to content taught in math and science aligned with K-8 standards scheduled by the School of Education. The Praxis courses are telling because they are designed to bolster students' foundational knowledge of key concepts and assist with the state-mandated Praxis exams to earn teacher certification in mathematics and science.

Table 2. Existing courses aligned with K-8 mathematics & science topics

Course	Enrollment
EDUC 1171 Praxis Science (new)	27
EDUC 1151 Praxis Mathematics	61
GNM 2138 Scientific Inquiry	91

To provide an additional measure of student interest in LIBA STEAM, the TEDU Program conducted a short survey of all students, 807 as of Fall 2017, that, at entry to Stockton, indicated they had an interest in teacher certification (done through a tracking attribute used by the TEDU Program). A three question survey was used to track interest in teacher education, middle school endorsements, and if there was specific interest in a LIBA STEAM concentration option. (See Appendices for full survey and data.) The survey adjusted automatically for respondents based on the responses provided. For example, if a student responded that they did not wish to earn teacher certification they would not answer the other questions about teacher certification areas. This ensured that those responding to the question about the LIBA concentration were only those that said they had an interest in teacher certification and middle school endorsement. Table 3 represents all respondents. Overall, there was a 47% response rate with 383 students responding to the TEDU survey.

Table 3. TEDU Program Interest Survey responses		
Q1 - Please check all that apply about your interest in teacher certification:		# of responses
1	I am not interested in becoming a certified teacher	14
2	I am interested in becoming an early education teacher (PreK-3)	49
3	I am interested in becoming an elementary teacher (K-6)	145
4	I am interested in becoming a secondary teacher (K-12 or 7-12)	110
5	I am interested in becoming a middle school teacher (6-8)	65
	Total respondents	383

Of the 383 respondents, only those that indicated an interest in middle school specialization received the question about the proposed LIBA STEAM concentration. Shown in Table 3 is the 198 responses received sorted by gender and ethnicity. As a whole, 86% of respondents had some or great interest in the concentration. In addition, those in underrepresented populations (percentages can be read across the row of each category) including females and minorities showed interest and would potentially elect a LIBA STEAM path if given the option. In all, 110 students representing 56% of the 198 respondents has strong interest in the degree.

Table 4. Interest in LIBA STEAM proposed degree				
	Very Little Interest	Some Interest	Very Much Interested	Grand Total
Females	15%	27%	58%	161
African American	33%	0%	67%	6
Asian/Pacific Islander	17%	50%	33%	6
Caucasian	14%	24%	62%	129
Hispanic	10%	50%	40%	10
Two or More Races	20%	40%	40%	10
Males	14%	43%	43%	37
African American	0%	0%	100%	1
Asian/Pacific Islander	0%	100%	0%	1
Caucasian	16%	38%	47%	32
Hispanic	0%	100%	0%	3
Grand Total	15%	30%	56%	198

Beyond data to support potential interest in this concentration there is also the motivation of being more marketable to potential K-12 employers. With over 200 students just at Stockton seeking elementary endorsements there is an advantage to selecting a degree that offers additional qualifications to stand out among graduates. In the case of the LIBA STEAM a student would earn a Liberal Arts Degree, elementary certification and middle school specializations in both mathematics and science if they follow the curriculum as set. Additionally, they would have a degree in STEAM, a topic that has drawn national attention for its value in K-12 settings and beyond. For a school district seeking to strengthen their STEM/STEAM programs, a novice teacher with exposure to this area would be of great value in establishing and/or strengthening their existing efforts. Beyond that, the student would be well suited for the position due to the design and structure of the program.

Target group

The group targeted for this new concentration are from within the LIBA degree. Additionally, there is the potential of attracting students who come in with a specific interest in teaching mathematics or science but find the pure degree not suitable to their needs or abilities (ie. MATH w/EDUC or BIOL w/EDUC) This is visible during times like summer orientation/registration. A student wants to be a mathematics teacher but doesn't have high enough SAT scores, struggled in high school level topics and so may not be well suited for teaching secondary level. The LIBA STEAM would still allow students to specialize in math or science studying a concentration of mathematics and science areas but not delve as deeply into a single topic necessary for teaching secondary level. The TEDU Interest Survey conducted provides an idea of interest by degree/concentration for current students. Table 5 below disaggregates students with some or great interest in the LIBA STEAM by current degree area. The majority of students are from the current LIBA degree.

Table 5. Interest in LIBA STEAM by major

Major	**Some Interest**	**Very Much Interested**	**Grand Total**
ARTS		5	5
BIOL-BA/BS	1	3	4
CHEM-BS		1	1
ENVL-BA/BS	2		2
HIST	7	5	12
LCST	1		1
LIBA	23	58	81
LITT	5	6	11
MARS-BA	1	2	3
MATH-BA	4	8	12
PHYS-BA/BS		3	3
POLS	1	1	2
PSYC-BA	11	6	17
PUBLIC-HLTH		1	1
TEDU-BA	3	11	14
Grand Total	**59**	**110**	**169**

Curriculum

Goals/outcomes

The proposed LIBA STEAM would follow the overall structure of existing LIBA concentrations. This includes a set of program courses, cognates, ASD and General Studies courses. A draft curriculum worksheet is provided in the Appendix for review. Overall the LIBA STEAM includes the following categories for a total of 134 credits.

- **Program- 47 credits/11 courses**- Program courses are the core of the degree and offer study specific to liberal arts areas taught in school and relevant to STEAM education. To provide a sense of how the program works in comparison to other LIBA concentrations a comparison is shown in Table 3. All courses listed are selected to align with the necessary foundations for elementary school teachers with a purposeful emphasis on STEAM. There is, by design, a heavier emphasis on mathematics and science.

This is necessary to earn middle school specializations that require at least 15 credits of study in the subject to earn the endorsement.

- **Cognates- 22 credits/5 courses** (including Final Clinical Practice/Student teaching)- Cognates are courses related to the major so these include any courses with a direct connection to STEAM areas.
- **ASD- 33 credits/11 courses**- ASD courses for the LIBA STEAM are mainly required education courses necessary for teacher certification but that do not directly link to math, science, technology or art.
- **General studies- 32 credits/8 courses**- General studies follows the Stockton structure with the inclusion of suggested G courses that aligns to K-8 content areas and STEAM study. These are suggestions so a student could elect to take another G if they wish. (However, this can have an impact on earning middle school specializations and on performance on the Praxis II. This is the reason behind offering suggested options.)

The overall design of the concentration is done to purposely offer depth and coherence for the degree. The coherence is within the design of the program. The ***program courses*** offer a blend of STEAM topics with the heaviest emphasis on mathematics and science since middle school specialization is targeted. The courses listed align intentionally with middle school standards and the mandatory Praxis II test. With the need to pass the Praxis II in all content areas, there is also a designated course in language arts and social studies. There is one new course proposed within the Program courses, EDUC 4xxx *STEAM Education*. This course, described in a future section, serves as a culminating course illustrating how interdisciplinary instruction works within science, math, technology and art in the K-8 setting. With all program courses, there is a girth of study in core program areas (ie. MATH, ENVL, CSIS, LITT, HIST, etc). This ensures a level of rigor in study and depth of understanding of advanced concepts especially within mathematics and science appropriate for elementary and middle school certification.

Beyond the program courses, the General Studies curriculum is also purposely used to further strengthen foundational knowledge in liberal arts areas. In some cases, G courses are listed that align to K-8 standards and Praxis II. There is also a section on the back of the curriculum worksheet (see Appendix) that offers suggested G study in art, digital literacy, and computer science/information system areas. While the study is broader in nature the coursework can further deepen an understanding of the interconnected nature of science, math, technology and art.

Table 3. Program course comparison among LIBA concentrations (existing and proposed)

	LIBA ELEM	LIBA LASS	LIBA STEAM (proposed)
Program course breakdown	2 Science courses 2 Math courses 2 Social Studies courses 2 Language Arts courses 2 courses (any of the above)	4 Language Arts courses 4 Social Studies courses 1 Math courses 1 Science course	3 Mathematics courses 3 Science courses 1 Art course 1 Tech course 1 Language Art course 1 Social Studies course 1 Interdisciplinary course (STEAM)

Faculty

A large number of faculty could potentially contribute to the LIBA STEAM. To ensure capacity to offer the degree faculty leaders of their respective programs were consulted that offer courses within the proposed concentration path. In addition, all coordinators of all programs potentially impacted were consulted including all branches of science per the Academic Program & Planning Committee request. Keep in mind that courses with the exception of EDUC 4XXX *STEAM Education* already exist and are part of many different programs. To give a sense of some of the contributors I listed faculty with whom I consulted on this degree concentration:

- Chia Lin Wu (NAMS-Math Coordinator)
- Tara Luke (NAMS-Science & STEM Collaborative member)
- Elizabeth Pollock (NAMS- CHEM Coordinator)
- Daniel Hernandez (NAMS- BIOL Coordinator)
- Gordan Grguric (NAMS- MARS Coordinator)
- Patrick Hossay (NAMS- Sustainability Coordinator)
- Matthew Severs (NAMS- GEOL Coordinator)
- Tait Chirenje (NAMS- ENVL Coordinator)
- Kelly Keenan (NAMS- BCMC Coordinator)
- Jason Shulman (NAMS- Science & STEM Collaborative member
- Pam Cohn (NAMS- Science & STEM Collaborative member)
- Wendell White (ARTV Coordinator)
- Mariana Smith (ARTV)
- Aakash Taneja (CSIS Coordinator)
- Doug Harvey (MAIT Director)

Additionally, all School of Education faculty were informed and consulted in the creation and design of this degree. Beyond faculty, administration in the varied schools impacted were consulted including:

- Peter Straub- Dean of NAMS
- Claudine Keenan- Dean of SOE
- Peter Hagen- Associate Dean of General Studies & Director, Center of Academic Advising

Courses

Coursework required is described earlier within the goals section. The overall LIBA STEAM design fulfills Bachelor of Arts requirements including a minimum of 64 credits in program and cognate (69 in LIBA STEAM), 32 credits in general studies and 32 ASD credits (33 in LIBA STEAM). In terms of level of study, there is significant coursework at the 3000 & 4000 level for a total of 42 credits. Also noteworthy in terms of rigor is the nature of a degree leading to certification. As such there are several requirements embedded in LIBA STEAM that surpass minimum degree expectations such as:

- Earning a C or better in all content courses
- Earning a B- or better in all professional education courses (all at 3000/4000 level)
- Earning an overall GPA of 3.0 or higher and
- Passing of state assessments including Praxis Core (math, reading & writing), Praxis II (language arts, mathematics, science and social studies, and edTPA (a performance assessment linked to the content and grade level of student teaching)

An additional consideration of courses is availability of sections and any necessary prerequisites for them. In the case of the LIBA STEAM, all but one course are already offered and sustained through other elementary teacher certification paths including LIBA ELEM & LASS. Coursework requiring prerequisites are limited to the professional education courses. These courses are the same for all elementary certification students regardless of the concentration or path they choose. Thus, the School of Education is already equipped and able to support course demand. One new course is proposed for this degree, EDUC 4XXX STEAM Education. This course would need to be offered on a regular basis. However, the School of Education has several faculty qualified and able to teach the course. Additionally, the intent of this course is to work collaboratively with other programs to design a truly interdisciplinary experience. MAIT and ARTV representatives have already expressed an interest when the time comes to offer it. We also maintain a STEM Collaborative on campus and have many K-12 partners with STEM programming that would help to support such a course.

Resources

No additional resource needs are anticipated for this concentration. Stockton currently sustains a high number of LIBA candidates. The School of Education also has necessary technology, materials and equipment that would be requested. This includes a full library of STEM related tools/materials and maker space housed within the SRI-ETTC available for project needs.

Possible concerns and solutions

There are no foreseen concerns for the proposed concentration. This concentration is similar to existing LIBA ELEM and LASS designs. With an already high number of students in the more general LIBA path, it is likely that students would simply shift from a general degree area to more specified path. Courses within the degree are regular offerings in the Stockton curriculum so there are many options each semester on what a student might take. Towards the end of the program, the School of Education does monitor and anticipate enrollments. At the moment, our graduates are on the decline (ie. Student teaching enrollments are down by 16% (58 to 49 in one semester) so having an additional concentration leading to endorsement would not burden existing program courses.

Housing

The proposed LIBA STEAM would be housed in the Liberal Studies program along with the existing LIBA ELEM and LASS concentrations. EDUC faculty would serve as the preceptor for these programs, again, similar to the existing LIBA structure.

Timeline

- Fall 2017- Review and approval of new LIBA concentration (APP & Faculty Senate)
- Winter 2017- Revise Bulletin, submit course workflow for new course (EDUC 4XXX) and LIBA STEAM design
- Spring 2018- Update admissions on new certification path option and work with SOE administration to update program tracking data
- Summer 2018- Formally announce and allow students to declare the new LIBA concentration

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Appendices

A. Stockton STEAM Flyer & STEAM presentation by K. Landsbergen
B. Hanover Research Data (provided by C. Hood.)
C. TEDU Interest Survey for LIBA STEAM (questions, raw data on respondents and resulting tables)
D. Draft curriculum worksheet for LIBA STEAM

Stockton STEAM

November 17, 2016 12:30 p.m. - 2:20 p.m. • MCB 126

Additional student critiques and visits scheduled throughout the day

November 18, 2016 2:00 p.m. - 4:00 p.m. • MCF 207




Art/Science collaborations have the power to be synergistic in a way that science alone cannot be. Contemporary artistic practice has much to offer. Scientists seeking artistic collaboration must be ready to engage in true collaboration, to move beyond naive expectations of representational art. This workshop will feature examples of art/science collaborations, and present methods for cross-disciplinary engagement, opening conversations between faculty and students in STEM disciplines with the Arts and Humanities.

Kim Landsbergen will facilitate a 2-hour faculty development workshop for Stockton's faculty to explore art/science collaboration and to identify interest level, pathways and partnerships. Additional examples of incorporation of art/science work into the classroom will also be provided.

This workshop will inaugurate Stockton STEAM, a series of annual events celebrating and promoting interdisciplinary work and ideas in the arts and sciences.

Kim Landsbergen Ph.D. is an Associate Professor of Biology and Environmental Science at Antioch College in Yellow Springs Ohio. She is a plant ecologist with a focus on climate change, invasive biology, and human impacts on terrestrial ecosystems. Over the last 6 years she's been working alongside and making collaborative works with artists. During 4 years as faculty at the Columbus College for Art & Design, she taught courses in Ecology, Biomimicry, and Infographics. At Antioch College, she collaborates with social scientists and artists on sustainability action. She also specializes in art/science communication and translation across disciplines.

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The Heart is a Better Lever Than the Mind:
Why Scientists Must Collaborate with Artists

ANTIOCH COLLEGE

Kim Landsbergen Ph.D.
Associate Professor of Biology and Environmental Science
Antioch College, Yellow Springs OH

Stockton University
18 Nov 2016

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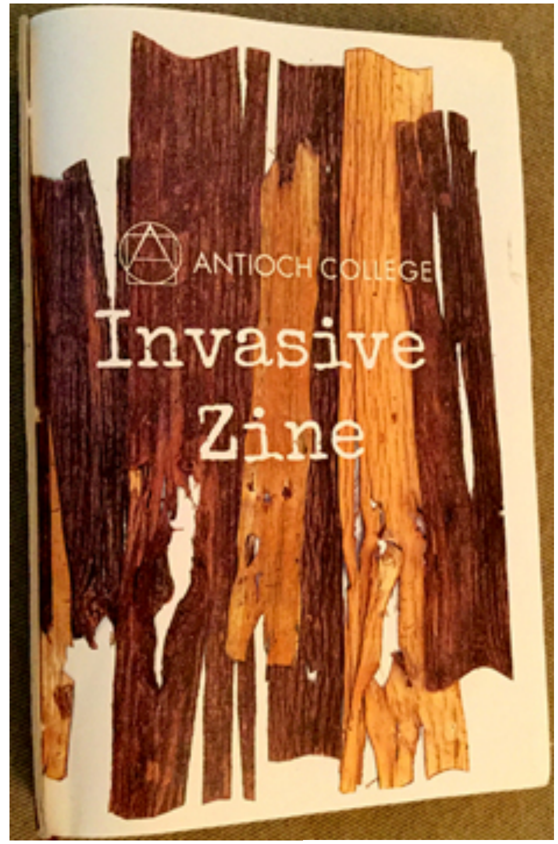

1. Who am I, and why am I here?
2. Why this talk? Why now?
3. A call to action: Scientists, jump in!
4. How to start? Some examples.
5. Barriers to #Art:Sci, and doing it anyway

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A wake-up call:
Science Journalists = outsider views


●●●○○ Verizon LTE 8:20 PM
Tweet
Jens Svenning
@JCSvenning
Twice as many attending #mylittlepony conference than juxtaposed #ecology science meeting - something to learn? #ESA100
8/9/15, 6:01 PM from Baltimore, MD
3 RETWEETS 6 FAVORITES
K Fortino @KennyPeanuts 1h
@JCSvenning Not only numbers but bronies there on own $ and time.
Reply to Jens Svenning
1
Timelines
Notifications
Messages
Me

Whimsy! Delight! ***versus …***


ECOLOGICAL SOCIETY OF AMERICA

We have a problem:

peak urgency happening at the same time as peak disinterest

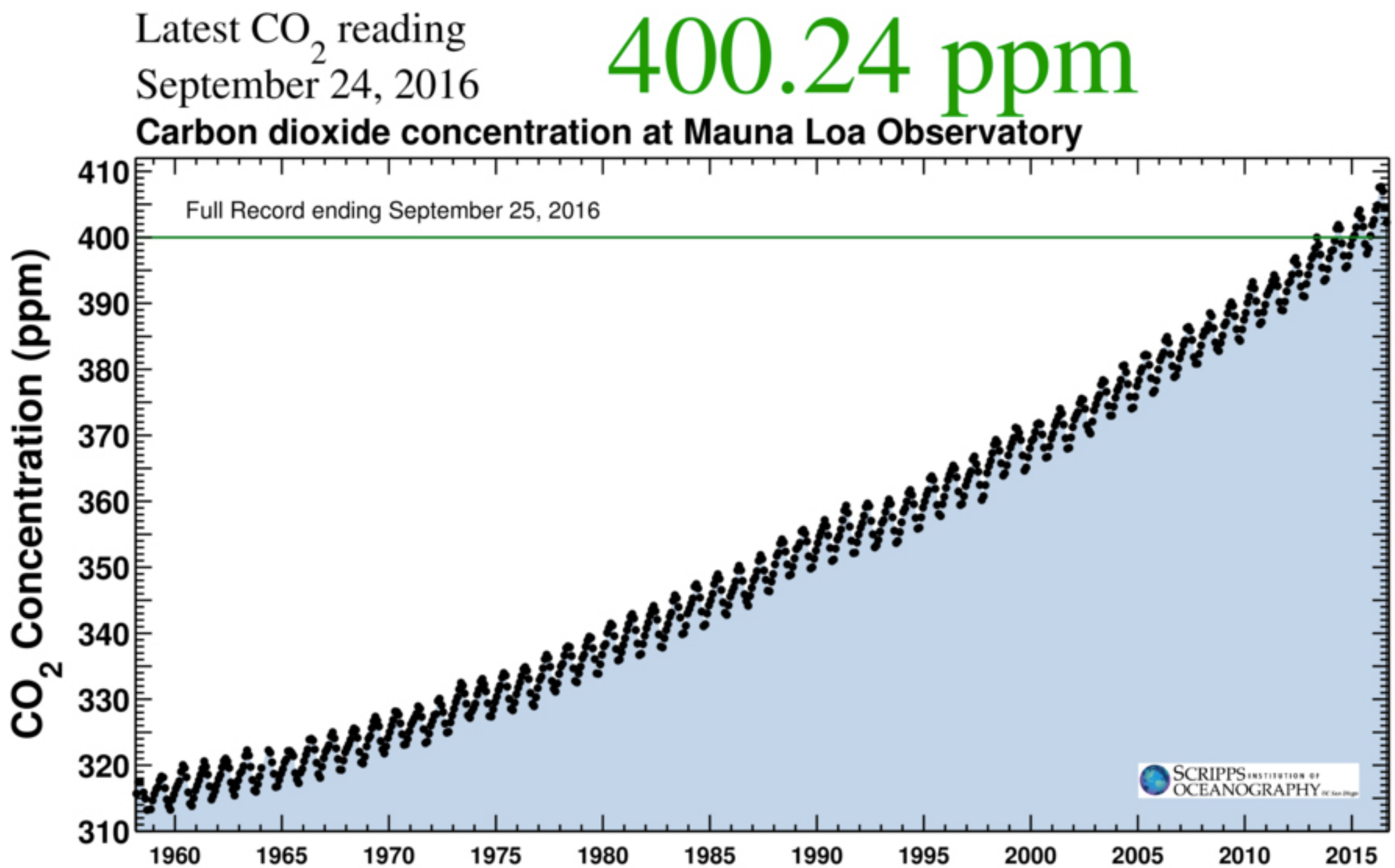
There's growing pressure for academics to get outside their comfort zones and to share their research with the broader public. campus via www.shutterstock.com

September 5, 2016

Why academics are losing relevance in society – and how to stop it

Academics are getting out of touch with the rest of society. This helps explains the sorry state of our public discourse on science.

Arguably, the most important dataset of the 20th century! How many American citizens understand this figure?



Making the case: <u>Why</u> do #Art:Sci?

Why? **Sometimes, art is better at communicating more complex ideas, quickly**

Nature 421, 805-806 (20 February 2003) | doi:10.1038/421805a

brief communications

Severe summertime flooding in Europe

Even as summers become drier, the incidence of severe precipitation could increase.

Using a high-resolution climate model, we are able to quantify the influence of greenhouse-gas-induced global warming upon heavy or extended precipitation episodes that inflict catastrophic flooding. We find that an increase in the amount of precipitation that exceeds the 95th percentile is very likely in many areas of Europe, despite a possible reduction in average summer precipitation over a substantial part of the continent. Our results indicate that episodes of severe flooding may become more frequent, despite a general trend towards drier summer conditions.

In the European Union project PRUDENCE (EVK2-CT-2001-00132; ref. 1),

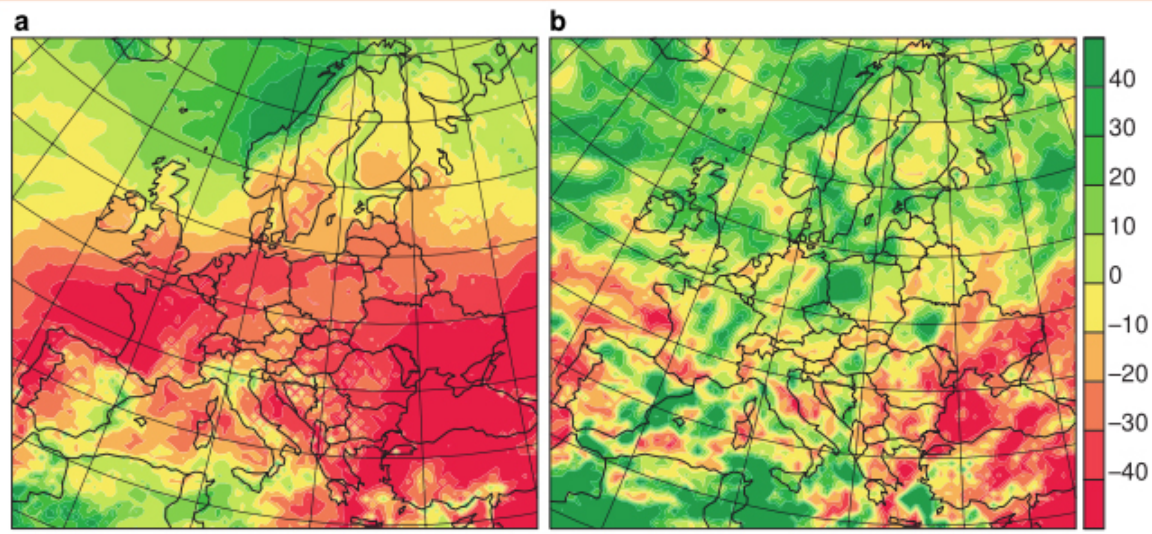


Figure 1 Relative percentage change in precipitation for July–September in the Intergovernmental Panel on Climate Change's A2 scenario with respect to the present day. Relative change is shown for **a**, the seasonal mean; and **b**, the five-day mean exceeding the 99th percentile.

Isaac Cordal (Spanish, b. 1974) Cement Eclipses Project, Berlin.

Why? Because you want your work to have an impact beyond your peers

- Why aren't my data influencing policy?
- Is my work *making a difference* in solving the problem I am documenting?

PUBLIC UNDERSTANDING OF SCIENCE

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Impact Factor: 1.904 | **Ranking:** History & Philosophy Of Science (SSCI) 3 out of 44 | Communicati

How scientists view the public, the media and the political process

John C. Besley

University of South Carolina, USA

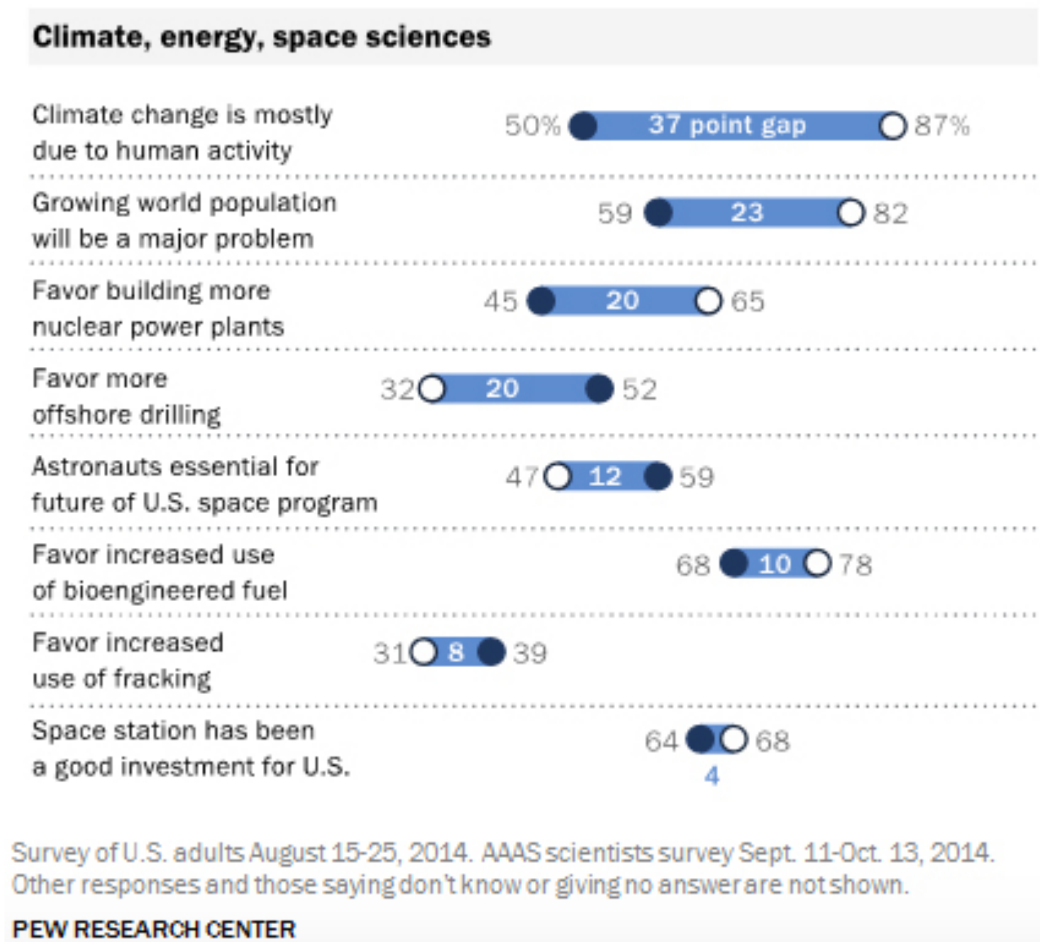
Matthew Nisbet

American University, Washington, DC, USA

John C. Besley, School of Journalism and Mass Communications, University of South Carolina, Columbia, SC 29208, USA. Email: jbesley@sc.edu

"Few scientists view their role as an enabler of direct public participation in decision-making through formats such as deliberative meetings, ***and do not believe there are personal benefits for investing in these activities."***

Why? Because we THINK we are doing a better job at science communication THAN WE REALLY ARE



"mind the gap"

Dark blue = public; Open circle = AAAS scientists

Why? **Because our budgets flow from politicians,** who are swayed by the concerns of their funder$ and by voters.

David Steen, Ph.D.
@AlongsideWild

Federal government is primary funder of science. Politicians create federal budgets & set priorities. Absolutely politics affect science.

9/21/16, 7:00 PM

1 RETWEET **3** LIKES

Why? **Because you have wondered:**
Is my "system" disappearing faster than I can document its status?

Why? Because creativity helps us be better scientists

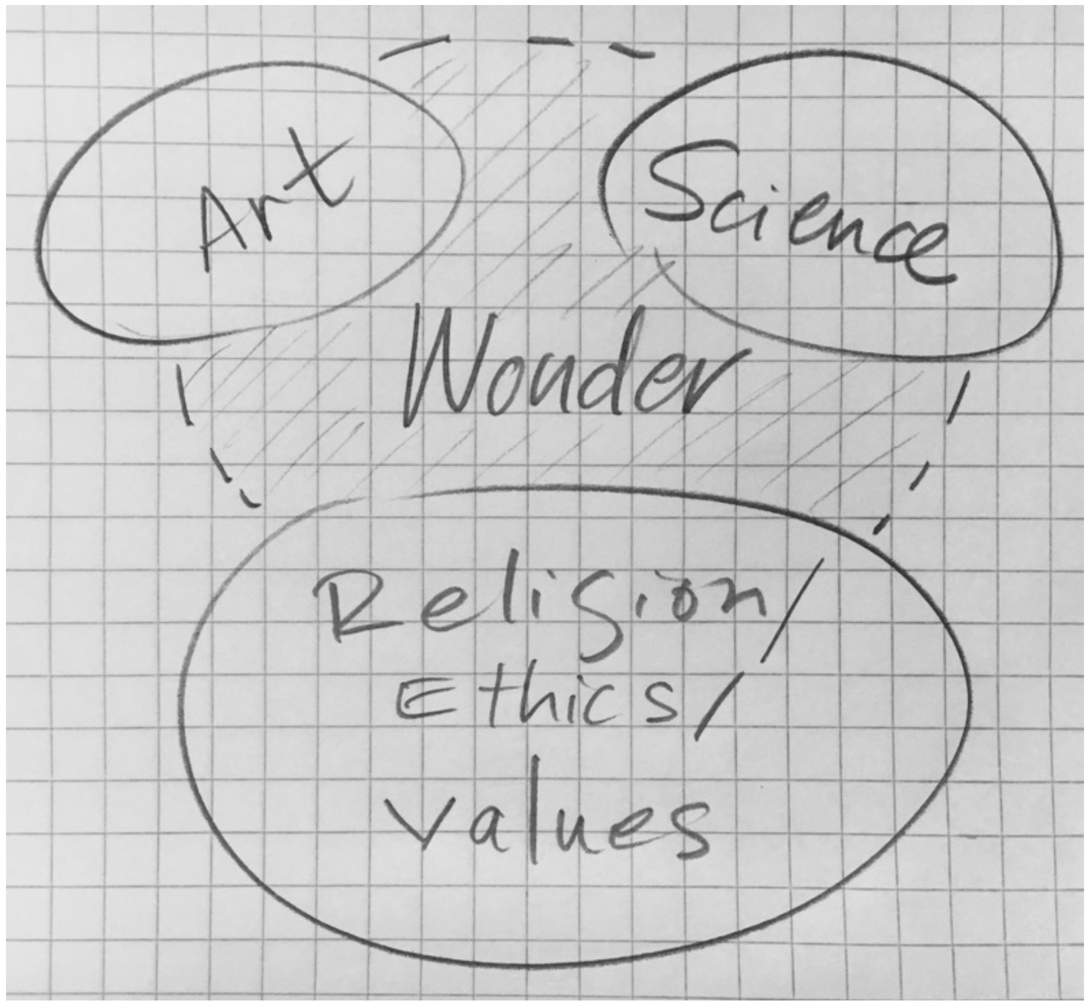
“Personally, I am getting many "viewpoint expanding" experiences out of our collaboration, which make me a better scientist. Because of the increasing complexity, we are all now all awfully locked into tiny mental cells, each one filled with more information than a person can possibly hope to grasp in a "gestalt" kind of way. This makes us look so boring to the "uninitiated". It's not our fault, but finding ways to overcome it is a fascinating, and important goal.”

– Prof. Iris Meier, OSU Molecular Biology
27 Sept 2016, email communication

Art:Science collaborations

are a *pathway to outreach and engagement*

Wonder: at the nexus



Some shared questions in science and art

- Does anyone else feel the **delight** and **wonder** I feel about this system?
- ***Why*** am I compelled to give countless hours of tedium and labor on this project?
- **Does anyone care** about the work I do beyond my small circle of professional comrades?

Art:Science collaborations

historically strong,
resurging again!

ART:SCIENCE COLLABORATION IS POPPING UP EVERYWHERE

CAREERS

BALANCE Five ways to break a work addiction for **go.nature.com/2bfstzt**

FIX SCIENCE Young researchers draft treatise for radical change **go.nature.com/2bhcmzt**

NATUREJOBS For the latest career listings and advice **www.naturejobs.com**

SEMICONDUCTOR

Joe Gerhardt, one-half of the UK artist duo Semiconductor, explores the archives at CERN with archivist Anita Hollier as part of the COLLIDE initiative.

ART-SCIENCE COLLABORATIONS

Change of perspective

Pick up a lump of clay or stare at a Leonardo water drawing — your science, not just your frame of mind, will benefit from it.

BY SHEILA MULROONEY ELDRED

After earning her PhD in Earth and planetary sciences, Johanna Kieniewicz found herself in a coveted tenure-track job. But as she dug more deeply into her work, she felt her field of vision narrowing — and not in a good way. Extreme focus left her worried that she was stifling her creative side.

"With the intensity of those sorts of jobs, it becomes all that you do," she says. "I was in danger of losing the bigger picture." To re-engage with her artistic side — she had always had a penchant for drawing and making things with her hands — she took a leave of absence and went to art school. There, she came to realize how skills taught in the art world could influence science. Asking difficult questions about purpose and ethics, or imagining both fantastic and terrifying futures, helps scientists to put their work in perspective, she says. She used her art experience to nab a dream job as head of outreach and engagement at the Institute of Physics in London, where she coordinates with art museums and theatres to pull the public into conversations about science. "Ultimately, both artists and scientists are asking big questions about the world," Kieniewicz says. "A lot of rich and exciting stuff is happening between them."

Although Kieniewicz took her affinity for art to the far end of the spectrum, attending art school is hardly a prerequisite for those who hope to expand their scientific horizons and frame an experiment differently or get past a sticking point. Even a rudimentary interest in art can help to shift a researcher's perspective. Routes into the realm include creating your own art, collaborating with artists and viewing art that resonates with you.

Making art can be very helpful for scientists when they are failing to make progress. "Sometimes you have to dive in deeply, but sometimes you're stuck and have to get unstuck," says Robbert Dijkgraaf, director of the Institute for Advanced Study in Princeton, New Jersey.

Nature
1 Sept 2016

"Ultimately, both artists and scientists are asking big questions about the world,"
[Johannah] Kieniewicz says.

"A lot of rich and exciting stuff is happening between them."

Science & Society

Science Communication Through Art: Objectives, Challenges, and Outcomes

Amy E. Lesen,[1,*] Ama Rogan,[1,2] and Michael J. Blum[1,3]

The arts are becoming a favored medium for conveying science to the public. Tracking trending approaches, such as community-engaged learning, alongside challenges and goals can help establish metrics to achieve more impactful outcomes, and to determine the effectiveness of arts-based science communication for raising awareness or shaping public policy.

HOT. OFF. THE. PRESS!

Trends in Ecology and Evolution, Volume 31, Issue 9, p657–660, September 2016

http://dx.doi.org/10.1016/j.tree.2016.06.004

Examples and how to get started!

Founded Dec 2012, now 123 members (faculty, staff, students)

STEAM members spending time, sharing ideas, now coauthoring grants & papers

"…this work is complimentary to disciplinary research" – R. Holowinsky

Pamela Theodotou, MFA
Media Specialist at OSU’s
Byrd Polar and Climate Research Center

“… science and climate change communication has brought to me a whole new world to express. Communicating science through art is a relatively new arena and its is **very exciting to see how artists are interpreting science visually and at the same time trying to maintain its factual integrity which is so important.** It also is an area where activism (in my area of climate change communication) is an integral component, and where in the past we might have seen art play a part in civil rights or war protest, this is a new area where we can use a progressive voice to exact understanding and change.

What you can do: ***Design an assignment***

challenge the student to express the scientific idea artfully. Engage in a conversation of aesthetics, construction, decisions, methods …

What you can do: __Start a conversation__

Seek the overlap between science and art and aesthetics.
Why are these patterns present in developmental biology?
What math underlies these patterns?

CO-TEACHING:

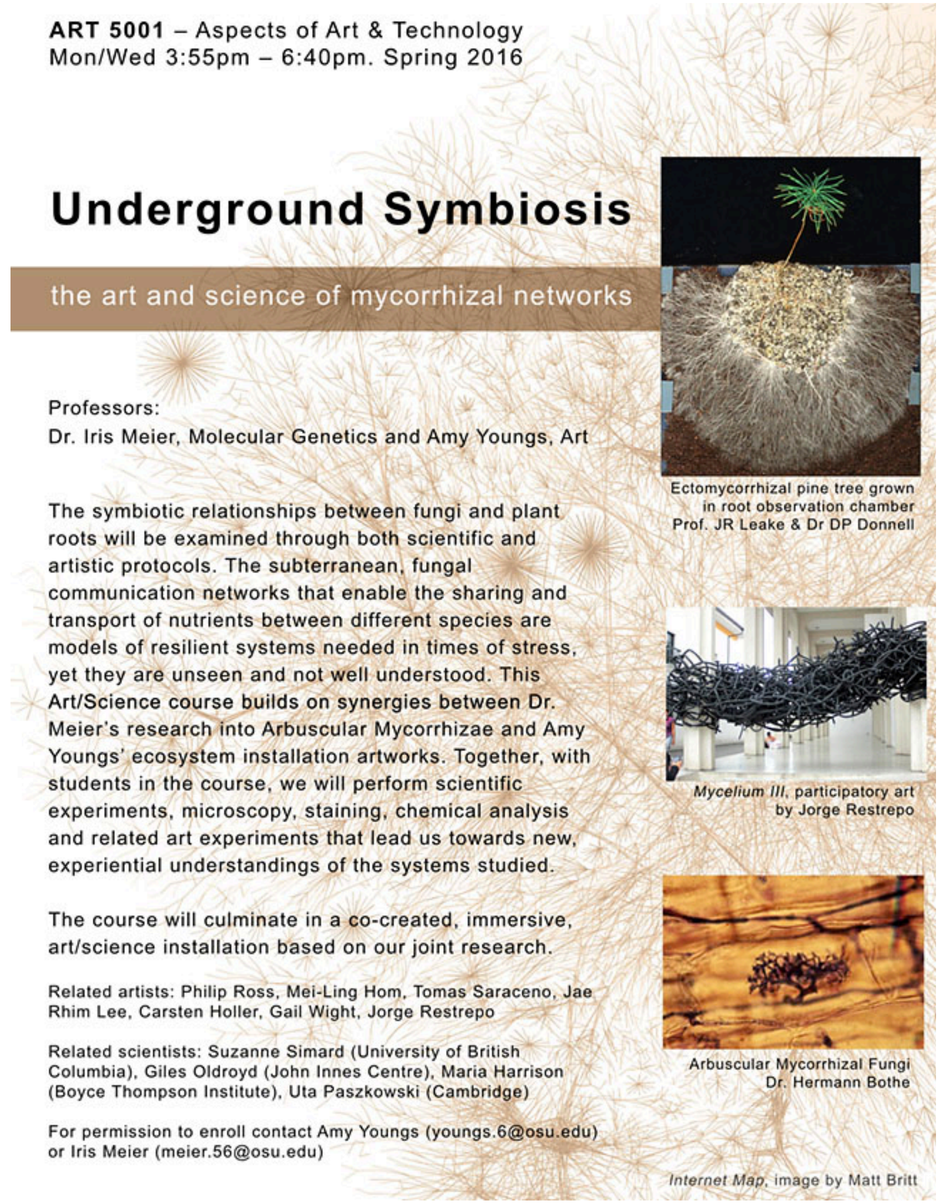
Another high-impact,

Low risk way to collaborate

Ohio State University course, Spring '15
ART5001 – Aspects of Art & technology

Prof. Amy Youngs
Art Department

Prof. Iris Meier
Molecular Genetics

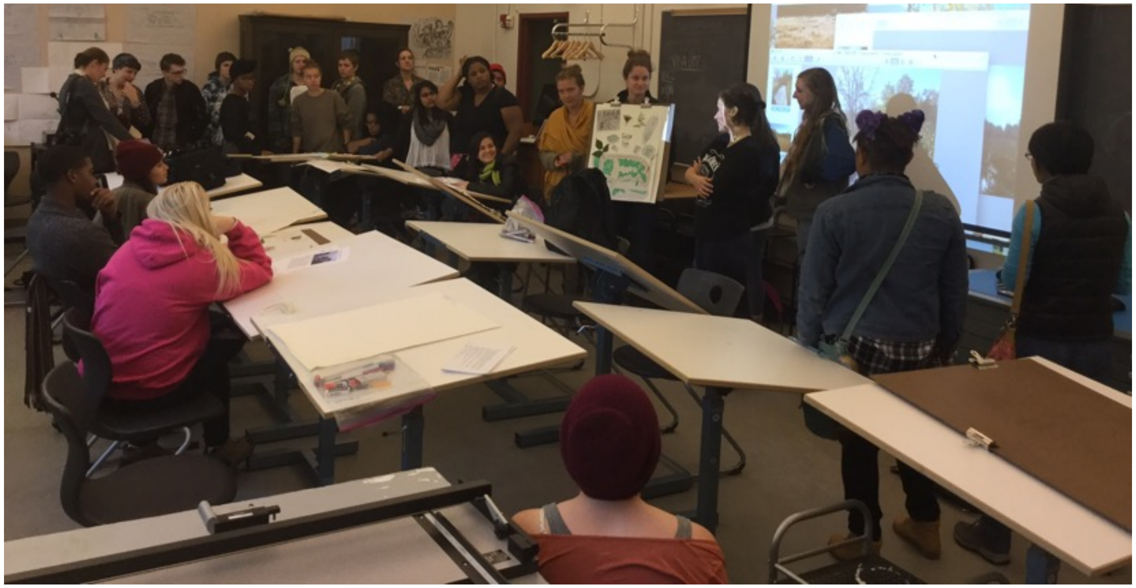


<u>Co-teaching can start small</u>
<u>And still be very successful</u>

Antioch College, Fall 2015 – combining

100-level Visual Art course (mapping the landscape)
100-level Intro Env.Science (measuring biodiversity)

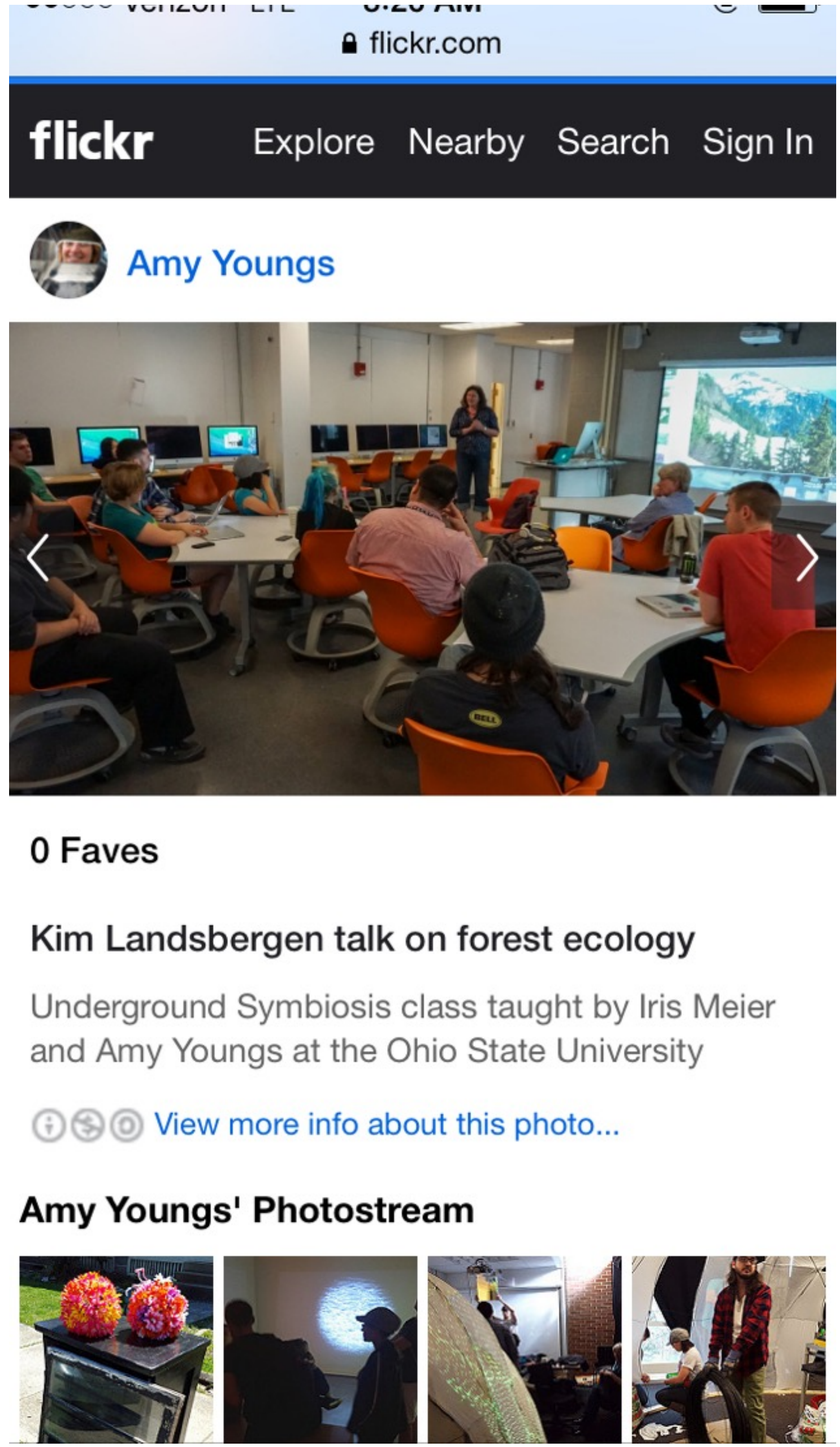
half-day intensive field trip plus
in-studio critique and discussion



Scientist visits in the studio, and Artist visits in the LAB a.k.a. 'critique', are another pathway to collaboration

Spring 2015 – Guest lecture, student discussion about organismal-level patterns and outcomes of fungi-tree symbioses in forests.

Prior to, students focusing on mechanism, cellular-level processes



Barriers to #Art:Sci collaboration

(or any interdisciplinary work)

B: “Distraction” is RISKY for pre-tenure faculty

- **ANY** work beyond your central discipline can be seen as a distraction or deterrent
- Art:Sci is often a “side gig”
- It’s hard enough to succeed *without* “distractions”

Smackdowns from advanced career colleagues devalue time spent on outreach

B: Do we have to wait for tenure until we commence in "risky" work out of the box? *A built-in deterrence to innovation in Higher Ed.*

"…my discipline is a bit suspicious of art/science collaborations, but I am choosing to ignore that and spend more time with those who are open to it."

- OSU Associate Professor Amy Youngs, Art Dept.
  26 Sept 2016, email communication

B: The tyranny of “impact metrics”

- If you are making/doing something really novel, does the Academy know how to value and evaluate your work? ***Critical to P+T***

  - The tyranny of the “Impact Factor”

  - Do grants exist to support that kind of work?
    (is absence of funding indicative of quality?)


home › opinion election 2016 US ≡ all

Research funding Opinion

Higgs would not find his boson in today's 'publish or perish' research culture

Jim Al-Khalili

An obsession with targets and impacts is killing off the blue-sky thinking that helped Higgs to a Nobel prize

"if we cannot break the government's obsession with impacts, measurable targets and almost immediate applications, not only will we be closing the door on any future Nobel prizes such as the one awarded to Higgs, but we will be losing our grip on the Haldane principle (that decisions about research spending should be made by researchers, not politicians)"

- Jim Al-Khalili, UK Physicist

Ecology and Society

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E&S HOME > PAST ISSUES > FEATURE (*IN-PROGRESS*) Open Access Publishing

Still from video: *Critical Transitions* made by Tone Bjordam and Marten Scheffer, 2012

Reconciling Art and Science for Sustainability 2015

Guest Editors: Frances Westley, Marten Scheffer, and Carl Folke

Why is science perceived as entirely different from art? Both attempt to capture the essence of the world around us in novel and eye-opening ways. Still the approaches are strikingly complementary. This suggests the potential for synergy. What can we learn from each other when it comes to the process of creative inquiry? Could we cooperate to fathom the unknown unknowns, finding important new questions that we had never thought of? This special feature invites papers on the topic of how art and science may be integrated for transformative understanding, increased motivation and new insights into how to build social ecological resilience.

"…[we] argue that ***scientific progress may be catalyzed by creating conditions for such associative intuitive thinking in our academic lives and in education***. ***Unstructured socializing time, education for daring exploration, and cooperation with the arts are among the potential elements. Because such activities may be looked upon as procrastination rather than work, deliberate effort is needed to counteract our systematic bias."***

! !

Scheffer et al. (2015) Dual Thinking For Scientists. http://dx.doi.org/10.5751/ES-07434-200203

What #Art:Sci looks like for me:

an example with invasive honeysuckle, an ecologist, and a multi-media artist

#Art:Sci is a way to connect to socially engaged practice

Share +

Jon Rubin: Conflict Kitchen

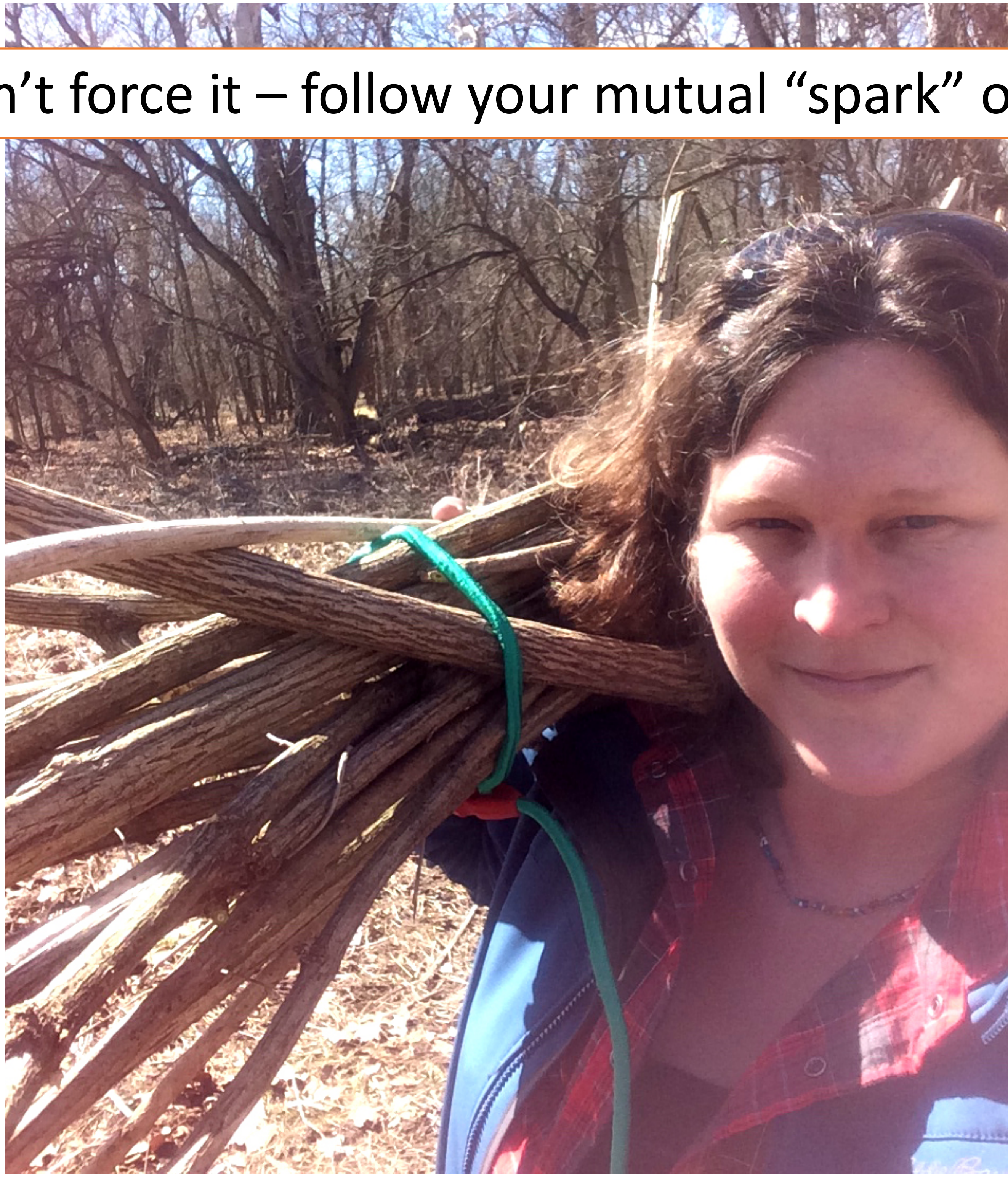
January 16, 2015

Chelsea Haines talks with artist Jon Rubin about the surprisingly controversial politics of serving Palestinian food in Pittsburgh.

Elena Harvey Collins, Untitled, 2011, vinyl lettering and signage, dimensions variable

AntiochZINE
began with a
conversation about
Megan Heeres'
"invasive plant" paper

1. Don’t force it – follow your mutual “spark” of interest




tileshop.com

2. Art is also a way of gaining knowledge about biology

3. Lots of supporters, contributors, collaborators!

4. Curating and designing the zine sparked a LOT of conversations about plants, invasives, etc.

5. Received as an object of delight: no one has ever been this stoked to read a peer-reviewed paper

Stockton STEAM

November 17, 2016

12:30 p.m. - 2:20 p.m. • MCB 126

Additional student critiques and visits scheduled throughout the day

November 18, 2016

2:00 p.m. - 4:00 p.m. • MCF 207

Art/Science collaborations have the power to be synergistic in a way that science alone cannot be. Contemporary artistic practice has much to offer. Scientists seeking artistic collaboration must be ready to engage in true collaboration, to move beyond naive expectations of representational art. This workshop will feature examples of art/science collaborations, and present methods for cross-disciplinary engagement, opening conversations between faculty and students in STEM disciplines with the Arts and Humanities.

Kim Landsbergen will facilitate a 2-hour faculty development workshop for Stockton's faculty to explore art/science collaboration and to identify interest level, pathways and partnerships. Additional examples of incorporation of art/science work into the classroom will also be provided.

This workshop will inaugurate Stockton STEAM, a series of annual events celebrating and promoting interdisciplinary work and ideas in the arts and sciences.

Kim Landsbergen Ph.D. is an Associate Professor of Biology and Environmental Science at Antioch College in Yellow Springs Ohio. She is a plant ecologist with a focus on climate change, invasive biology, and human impacts on terrestrial ecosystems. Over the last 6 years she's been working alongside and making collaborative works with artists. During 4 years as faculty at the Columbus College for Art & Design, she taught courses in Ecology, Biomimicry, and Infographics. At Antioch College, she collaborates with social scientists and artists on sustainability action. She also specializes in art/science communication and translation across disciplines.

STOCKTON UNIVERSITY

The School of Natural Sciences & Mathematics

The School of Arts & Humanities

stockton.edu/arhu

New Jersey's Distinctive Public University

Stockton is an AA/EO University

What might collaboration with a colleague look like?

Artist
(media, installation art)

Scientist
(ornithology, animal behavior)

0
none / minimal

1
fully

Time needed to exchange ideas, find spaces of common interest, imagine potential work together

Recognize and discuss ***common methods*** in Art:Science

- Observation
- Analysis
- Research
- Tinkering / Trial and error
- Capturing sparks of inspiration
- Apprenticeship / mentoring
  "10,000 hours of skill-building"

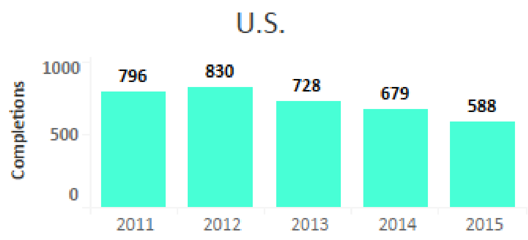
Artists and Scientists have MUCH in common, a mutual sandbox for productive collaboration

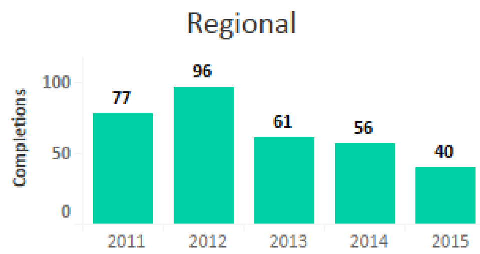
Science Teacher Education

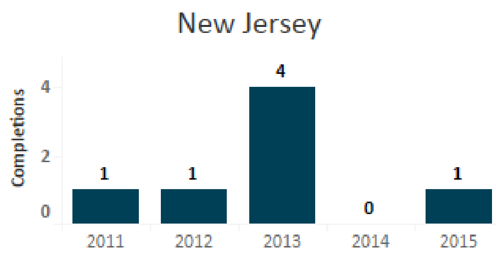
HANOVER RESEARCH

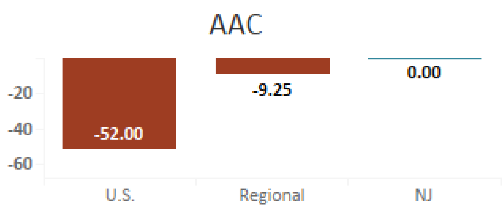
Completions

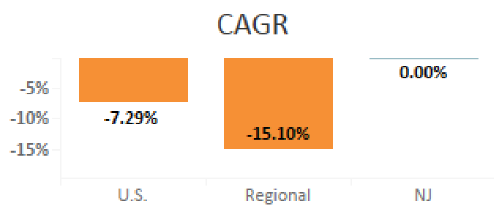
Select CIP 13.1316: Science Teacher Education/General Science Teacher Education

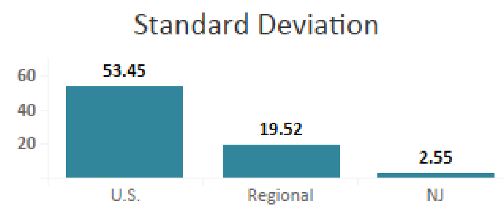






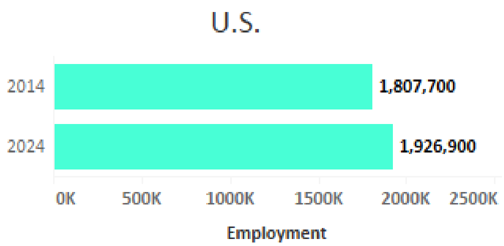


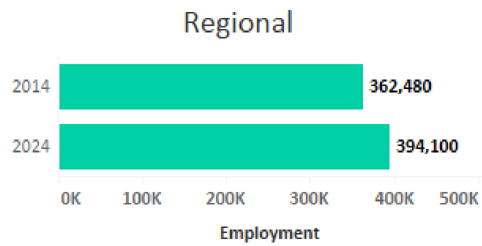


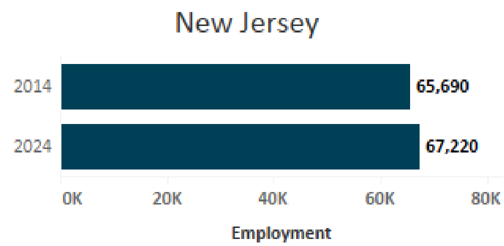


Labor Market Projects

Select CIP 13.1316: Science Teacher Education/General Science Teacher Education.







US Change #	119,200
US Change %	6.59%
US Openings	52,500

Regional Change #	31,620
Regional Change %	8.72%
Regional Openings	11,380

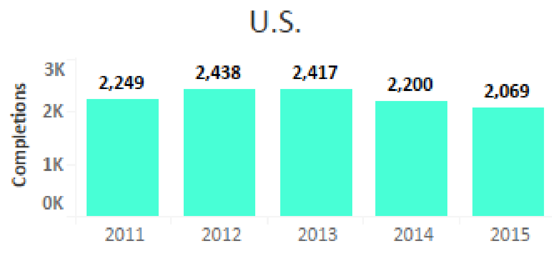
NJ Change #	1,530
NJ Change %	2.33%
NJ Openings	1,650

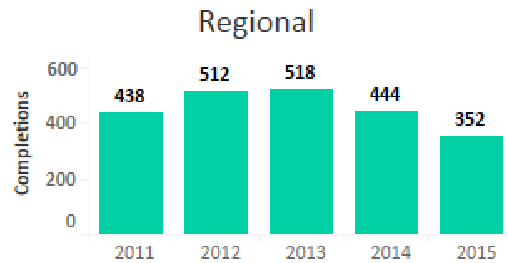
Mathematics Teacher Education, 13.1311

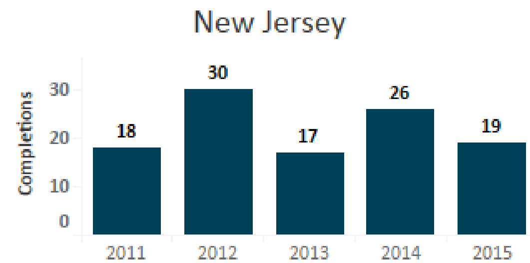
HANOVER RESEARCH

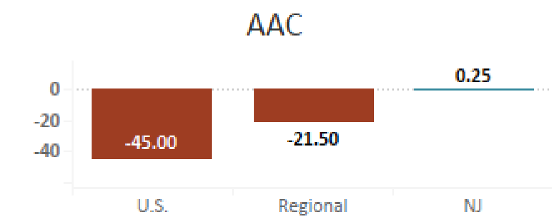
Completions

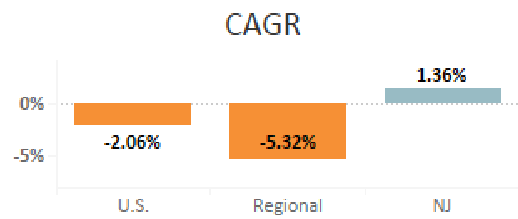
Select CIP 13.1311: Mathematics Teacher Education

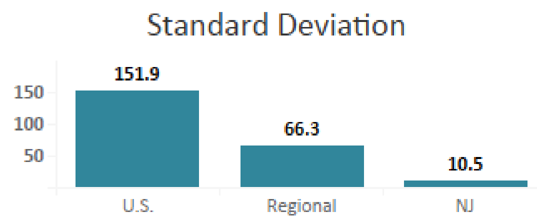






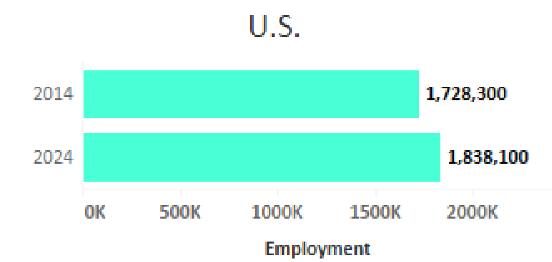


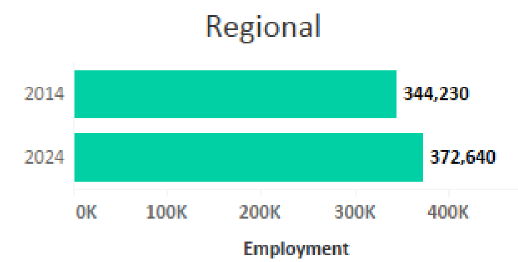


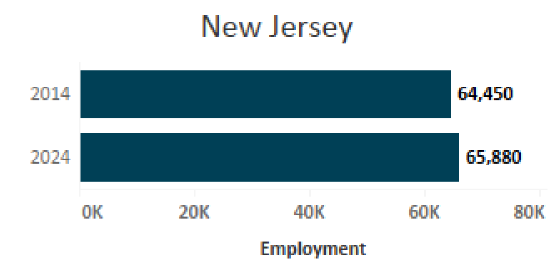


Labor Market Projects

Select CIP 13.1311: Mathematics Teacher Education.







US Change #	109,800	Regional Change #	28,410	NJ Change #	1,430
US Change %	6.35%	Regional Change %	8.25%	NJ Change %	2.22%
US Openings	50,150	Regional Openings	10,760	NJ Openings	1,620

TEDU Interest Survey (LIBA STEAM)
Last Modified: 2017-10-12 06:32:23 MDT

Q1 - Please check all that apply about your interest in teacher certification:

#	Question	IP Address	
1	I am not interested in becoming a certified teacher	100.00%	14
2	I am interested in becoming an early education teacher (PreK-3)	100.00%	49
3	I am interested in becoming an elementary teacher (K-6)	100.00%	145
4	I am interested in becoming a secondary teacher (K-12 or 7-12)	100.00%	110
5	I am interested in becoming a middle school teacher (6-8)	100.00%	65
			383

Q2 - Please check all that apply about middle school (6-8) endorsements that interest you:

#	Question	IP Address	
1	I am not interested in middle school endorsements at all	100.00%	48
2	I am interested in a middle school Math endorsement	100.00%	98
3	I am interested in a middle school Science endorsement	100.00%	76
4	I am interested in a middle school English endorsement	100.00%	102
5	I am interested in a middle school Social Studies endorsement	100.00%	80
6	I am interested in a middle school Spanish endorsement	100.00%	18
			422

Q4 - Please tell us your level of interest in the following possible future concentration at Stockton
IP Address

#	Question	Very Little Interest		Some Interest		Very Much Interested		Total
1	A Liberal Studies teaching concentration that blends Science, Technology, and Math (STEM)	25.13%	47	32.62%	61	42.25%	79	187
2	A Liberal Studies teaching concentration that blends STEM with Arts (STEAM)	24.74%	48	36.60%	71	38.66%	75	194

STE/A/M Interest Comb	Gender	Race/Ethni	Majr Code2	Program_C	Concentrat	Concentration 2
Very Much Interested	F		TEDU	ARTV-BFA	VPTG	ART
Very Much Interested	F	CA		MATH-BA	EDUC	
Very Much Interested	F	CA		LIBA	ELEM	
Very Much Interested	F	CA		LIBA	ELEM	
Very Much Interested	M	CA	TEDU	CHEM-BS		ELEM
Very Much Interested	F	CA	TEDU	ARTV-BFA	VPTG	ART
Very Little Interest	F	AS		PSYC-BA	ELEM	
Very Little Interest	F	CA		LIBA	ELEM	
Very Much Interested	F	AS		LIBA	ELEM	
Very Much Interested	F	CA		MATH-BA	EDUC	
Very Much Interested	F	CA	TEDU	LIBA	ELEM	ELEM
Very Much Interested	F	CA		LIBA	ELEM	
Some Interest	F	CA		POLS	EDUC	
Some Interest	M	CA	TEDU	PSYC-BA		ENGL
Some Interest	F	CA		LIBA	ELEM	
Very Much Interested	F	CA		LIBA	ELEM	
Very Little Interest	F	CA		LIBA	ELEM	
Some Interest	F	CA		LIBA	LASS	
Very Little Interest	M	CA		HIST	EDUC	
Very Much Interested	F	CA		LIBA	ELEM	
Very Much Interested	F	CA		PSYC-BA	ELEM	
Very Much Interested	F	CA		TEDU-BA	ELEM	
Some Interest	F	CA		LIBA	ELEM	
Very Much Interested	M	AA		POLS	EDUC	
Some Interest	F	HL		LIBA	ELEM	
Very Little Interest	M	CA		POLS	EDUC	
Very Much Interested	F	CA	TEDU	LITT	EDSC	ELEM
Very Much Interested	F	CA		TEDU-BA	ELEM	
Very Much Interested	F	CA		LIBA	ELEM	
Very Much Interested	F	CA		MATH-BA	EDUC	
Very Much Interested	F	CA		LIBA	ELEM	
Some Interest	M	CA		PSYC-BA	ELEM	
Some Interest	F	CA		LIBA	LASS	
Very Much Interested	F	CA		LIBA	ELEM	
Very Much Interested	F	CA		HIST	EDUC	
Very Much Interested	F	CA		TEDU-BA	ELEM	
Some Interest	M	CA		LIBA	LASS	
Some Interest	F	CA		TEDU-BA	ELEM	
Very Much Interested	F	CA		LIBA	ELEM	
Very Much Interested	M	CA		LIBA	ELEM	
Some Interest	F	CA		LITT	EDSC	
Some Interest	F	CA		PSYC-BA	MHLT	
Very Much Interested	F	AA		LIBA	ELEM	
Very Much Interested	F	HL		TEDU-BA	ELEM	
Very Little Interest	F	CA		HIST	EDUC	
Very Much Interested	F	CA	TEDU	HIST	EDUC	ELEM

Some Interest	F	CA		HIST	EDUC	
Very Little Interest	F	CA		LIBA	ELEM	
Very Much Interested	F	CA	TEDU	ARTS	PDST	
Very Much Interested	F	TW		LITT	EDSC	
Some Interest	F	CA		LIBA	ELEM	
Very Much Interested	F	CA	TEDU	BIOL-BS		BIOS
Very Much Interested	F	CA		LIBA	ELEM	
Some Interest	F	CA		PSYC-BA	ELEM	
Very Much Interested	F	AS		LITT	EDSC	
Very Little Interest	F	CA		HIST	EDUC	
Very Much Interested	F	CA		LIBA	LASS	
Some Interest	F	AS		MATH-BA	EDUC	
Very Little Interest	F	CA		LCST	EDFR	
Very Much Interested	F	CA	TEDU	ARTS	VIBA	ART
Some Interest	F	TW		PSYC-BA	ELEM	
Some Interest	F	CA		MATH-BA	EDUC	
Very Little Interest	M	CA		HIST	EDUC	
Very Much Interested	F	CA		LIBA	ELEM	
Some Interest	F	CA		LIBA	LASS	
Very Little Interest	M	CA		PSYC-BA	ELEM	
Very Much Interested	F	CA		LIBA	ELEM	
Very Much Interested	F	CA		MATH-BA	EDUC	
Very Much Interested	F	CA	TEDU	MARS-BA	EDUC	BIOS
Very Much Interested	F	AA		LIBA	ELEM	
Very Much Interested	F	CA	TEDU	ARTS	PMVO	ELEM
Very Little Interest	F	HL		LCST	WRLD	
Very Much Interested	F	CA		LIBA	ELEM	
Very Much Interested	M	CA		PHYS-BA	EDUC	
Some Interest	F	HL		BIOL-BA	EDUC	
Some Interest	M	CA		TEDU-BA	ELEM	
Very Much Interested	F	CA		LIBA	ELEM	
Very Much Interested	F	HL		LIBA	ELEM	
Very Little Interest	M	CA		LITT	LIST	
Very Much Interested	F	TW		LIBA	ELEM	
Very Much Interested	F	CA		LIBA	ELEM	
Very Much Interested	F	CA	TEDU	BIOL-BA	GENE	BIOS
Very Much Interested	F	CA		LIBA	ELEM	
Very Much Interested	F	CA		LIBA	ELEM	
Very Much Interested	F	CA		MATH-BA	EDUC	
Very Much Interested	F	CA		LIBA	ELEM	
Very Much Interested	F	CA		TEDU-BA	ELEM	
Some Interest	F	CA		ENVL_BS	WILD	
Very Much Interested	F	CA		LIBA	ELEM	
Very Much Interested	F	AA		LIBA	ELEM	
Some Interest	F	CA		LITT	EDSC	
Very Little Interest	F	CA		MATH-BA	EDUC	
Very Much Interested	F	CA		LIBA	ELEM	

Very Much Interested	F	CA		LIBA	ELEM		
Some Interest	F	CA		LITT	EDSC		
Very Much Interested	F	AA		TEDU-BA			
Very Much Interested	M	CA		PHYS-BA	EDUC		
Some Interest	F	CA		LIBA	ELEM		
Some Interest	M	CA		MATH-BA	EDUC		
Very Much Interested	F	CA		BIOL-BA	EDUC		
Very Much Interested	M	CA		LIBA	ELEM		
Very Much Interested	F	CA		LITT	EDSC		
Very Much Interested	F	CA		LIBA	LASS		
Very Much Interested	F	CA		PSYC-BA	ELEM		
Very Much Interested	F	CA		LIBA	ELEM		
Very Little Interest	F	CA		LIBA	ELEM		
Very Much Interested	M	CA		LIBA	ELEM		
Very Much Interested	F	CA		LIBA	ELEM		
Very Little Interest	F	CA		LIBA	ELEM		
Very Much Interested	F	CA		LIBA	ELEM		
Some Interest	F	CA		LIBA	ELEM		
Very Much Interested	F	CA		LIBA	ELEM		
Very Much Interested	F	CA		LIBA	ELEM		
Some Interest	M	HL		HIST	EDUC		
Some Interest	F	AS		LIBA	ELEM		
Very Much Interested	M	CA		TEDU-BA	SOST		
Very Much Interested	F	CA		LIBA	LASS		
Very Much Interested	F	CA		PSYC-BA	ELEM		
Very Much Interested	F	CA		LIBA	ELEM		
Very Much Interested	F	CA		TEDU-BA	ERTH		
Very Little Interest	F	CA		LCST	EDFR		
Some Interest	M	CA		PSYC-BA	ELEM		
Some Interest	F	CA	TEDU	ENVL-BA	EDUC		ERTH
Very Little Interest	F			TEDU-BA	ELEM		
Very Much Interested	F	CA		LIBA	ELEM		
Very Much Interested	M	CA		HIST	EDUC		
Some Interest	F	TW		PSYC-BA	ELEM		
Some Interest	F			LIBA	ELEM		
Very Little Interest	F	AA		LITT	EDSC		
Very Much Interested	F	CA		TEDU-BA	ELEM		
Very Much Interested	F	CA		LIBA	ELEM		
Very Much Interested	F	CA		MARS-BA	EDUC		
Very Much Interested	F	CA		LIBA	ELEM		
Some Interest	F	CA		TEDU-BA	ELEM		
Some Interest	M	AS		MARS-BA	EDUC		
Very Much Interested	F	CA		HIST	EDUC		
Very Little Interest	F	CA		PSYC-BA	ELEM		
Very Much Interested	F	CA		LIBA	ELEM		
Some Interest	F	CA		PSYC-BA	ELEM		
Very Much Interested	F	CA		PSYC-BA	ELEM		

Very Much Interested	F	CA	TEDU	PUBLIC-HL	CHED	ELEM
Very Much Interested	M	CA		LIBA	ELEM	
Very Much Interested	F	CA		PSYC-BA	ELEM	
Very Much Interested	F	CA		LIBA	ELEM	
Very Much Interested	M	CA		MATH-BA	EDUC	
Some Interest	F	CA		LITT	EDSC	
Very Little Interest	F	CA		LIBA	ELEM	
Very Much Interested	M	CA		LIBA	ELEM	
Very Much Interested	F	CA		TEDU-BA	SOST	
Some Interest	F	HL	TEDU	LCST	SPAN	LALT
Very Much Interested	F	CA		MATH-BA	EDUC	
Some Interest	M	HL		PSYC-BA	ELEM	
Very Little Interest	F	AA		PSYC-BA	ELEM	
Very Much Interested	M	CA		MATH-BA	EDUC	
Very Much Interested	M	CA		LIBA	ELEM	
Very Much Interested	F	HL		LITT	EDSC	
Some Interest	F	CA		LIBA	ELEM	
Very Little Interest	F	CA		TEDU-BA	SOST	
Some Interest	F	HL		LIBA	ELEM	
Some Interest	M	CA		LIBA	ELEM	
Very Much Interested	F	HL		LIBA	ELEM	
Some Interest	M	CA		HIST	EDUC	
Very Much Interested	F	CA	TEDU	LITT	THEN	ENGL
Very Much Interested	F	CA		LIBA	ELEM	
Some Interest	F	CA		LIBA	ELEM	
Some Interest	F	CA		LIBA	ELEM	
Some Interest	M	CA		HIST	EDUC	
Very Little Interest	F	CA		LIBA	ELEM	
Some Interest	F	CA		PSYC-BA	ELEM	
Some Interest	F	CA		LIBA	ELEM	
Some Interest	F	CA		LIBA	ELEM	
Very Much Interested	M	CA		HIST	EDUC	
Some Interest	M	CA		HIST	EDUC	
Some Interest	F	CA		LIBA	ELEM	
Very Little Interest	F	CA		PSYC-BA	ELEM	
Very Little Interest	F	CA		LIBA	ELEM	
Very Little Interest	F	CA		LITT	EDSC	
Very Much Interested	F	TW		LIBA	ELEM	
Some Interest	F	CA		LIBA	ELEM	
Very Much Interested	F	CA		LIBA	LASS	
Some Interest	F	HL		HIST	EDUC	
Very Little Interest	F	CA		LIBA	ELEM	
Very Little Interest	F	TW		LITT	EDSC	
Some Interest	M	CA		LIBA	LASS	
Very Much Interested	F	CA		LIBA	ELEM	
Some Interest	F	TW		PSYC-BA	ELEM	
Some Interest	F	CA		LITT	EDSC	

Some Interest	M	CA		LIBA	ELEM	
Very Much Interested	F	CA		LIBA	ELEM	
Some Interest	F	AS		MATH-BA	EDUC	
Very Much Interested	F	CA		TEDU-BA		
Very Much Interested	M	CA	TEDU	PHYS-BS	GENE	PHYS
Very Much Interested	F	CA		PSYC-BA	ELEM	
Very Much Interested	F	CA		LIBA	ELEM	
Very Much Interested	F	CA		LIBA	ELEM	
Very Much Interested	F	CA		LIBA	ELEM	
Very Much Interested	F	CA		LIBA	ELEM	
Some Interest	M	HL		HIST	EDUC	

Count of Reference	Column Labels			
Row Labels	**Some Interest**	**Very Little Interest**	**Very Much Interested**	**Grand Total**
F	**43**	**24**	**94**	**161**
AA		2	4	6
AS	3	1	2	6
CA	31	18	80	129
HL	5	1	4	10
TW	3	1	3	7
(blank)	1	1	1	3
M	**16**	**5**	**16**	**37**
AA			1	1
AS	1			1
CA	12	5	15	32
HL	3			3
Grand Total	**59**	**29**	**110**	**198**

	Very Little Interest	Some Interest	Very Much Interested	Grand Total
Females	24	43	94	161
African Amercian	2		4	6
Asian/Pacific Islander	1	3	2	6
Caucasian	18	31	80	129
Hispanic	1	5	4	10
Two or More Races	2	4	4	10
Males	5	16	16	37
African Amercian			1	1
Asian/Pacific Islander		1		1
Caucasian	5	12	15	32
Hispanic		3		3
Grand Total	29	59	110	198

	Very Little Interest	Some Interest	Very Much Interested	Grand Total
Females	15%	27%	58%	161
African Amercian	33%	0%	67%	6
Asian/Pacific Islander	17%	50%	33%	6
Caucasian	14%	24%	62%	129
Hispanic	10%	50%	40%	10
Two or More Races	20%	40%	40%	10
Males	14%	43%	43%	37
African Amercian	0%	0%	100%	1
Asian/Pacific Islander	0%	100%	0%	1
Caucasian	16%	38%	47%	32

Hispanic	0%	100%	0%	3
Grand Total	15%	30%	56%	198

BA in Liberal Arts w/STEAM Concentration
ELEMENTARY CERTIFICATION (K-6) with SPECIALIZATION (6-8)

Draft 10/4/17

While all bachelor programs require a minimum of 128 credits and a 2.00 cumulative GPA, the New Jersey Department of Education requires a 3.0 cumulative GPA to be certified. Students in this concentration must complete a LIBA major with accompanying EDUC courses as shown. A grade of "C" or better is required in all content courses and a B- or better in professional education courses. We recommend earning additional middle school endorsements beyond the two included on this worksheet. See attached recommendations that prepare students for the Elementary Praxis II and for the Middle School Praxis exams.

Student Name: ________________ Z______________________ Dates of Curr WS Review: ___, ____, _____, _____, _____

Preceptor: _________________________________

#1 LIBA STEAM BA Students should seek regular LIBA precepting for all program courses to meet BA requirements. Courses are recommended. Any substitutions must be approved by a preceptor and meet STEAM requirements.	Credits	C or Better
Math (precalculus or calculus) MATH 1100/2215	4	
Math (geometry) EDUC 2251	4	
Math (algebra) FRST/GNM 2310 or EDUC 1151	4	
Science– BIOL 1200/05 or 1400/05	5	
Science– GEOL 2120	5	
Science– PHYS 2220/2225	5	
Art *(ARTV)- ARTV 1125/1161/1162/1164/1169	4	
Technology *(Digital Literacy Minor approved or CSIS 2101, 2210, 1XXX recommended; except INTC 2610 & GEN 2018)	4	
EDUC 4XXX- *STEAM Education*	4	
Any non-G Lang Arts (LITT recommended)	4	
Any non-G Social Studies (EDUC 1161 or HIST recommended)	4	
Total Credits to Liberal Arts Major:	**47**	
Required Cognates from EDUC (at right)	**22**	
Students MUST earn C or better in all content courses for the Major and specializations. **A student may use a course in only 1 program category above. Thus, 1 core may not count for two areas of program.*		

#2 Required General Education– Also satisfy middle school specializations. Preceptors: Course choices impact licensure eligibility.	Credits	C or Better
GEN	4	
GIS	4	
GAH	4	
GAH (Lang Arts) 1151, 1627, 2116, 2258	4	
GNM (Math) 1110, 1124, 1125, 1154, 2161, 2180,	4	
GNM (Science) 1140, 2182, 2138	4	
GSS	4	
GSS (Social Studies) 2211	4	
Total General Studies required	**32**	
General Studies Writing Requirement - 4 courses- Two W1 courses may be transferred. W2 courses must be at Stockton. ____W1 ____W1/W2 ____W1/W2 EDUC4600 W1/W2 3000 level		
General Studies Quantitative Reasoning Requirement - 3 courses- Two Q1 courses may be transferred. Q2 courses must be taken at Stockton ____Q1 _EDUC 4150_Q2 _____Q1 or Q2		
General Studies Outcome Requirement: These courses are listed as attributes ___A (Arts) ___H (Historical Consciousness) ___FSEM EDUC1515 V (Values/Ethics) ___I (International/Multicultural)		
#3 Required At-Some-Distance courses: from *right*	Credits	B- or Better
Total At-Some-Distance required	**33**	

Middle School Specializations (drawn from above)– *15 credits minimum of coursework in content area & Middle School Praxis II test required*	
Language Arts	Social Studies
Math *(three 4 credit Program + GNM math)*	Science *(three 4-credit Program + GNM science)*

#4 Professional Requirements*: Grades of C or better required (equiv. transfer credits can be accepted)-* **16 credits at left**	***Credits***	***Grade***
EDUC 1515 Diversity in Fam, Schl & Commun. (4 cr ASD, V) or equiv, also accepted: GAH 1360; GEN 2126; GSS 1044, 3360, 3516; SOCY 2745		
EDUC 2241 Inclusive Learning in Education (4 cr ASD) also accepted GSS 2330,2340		
INTC 2610 Instructional Tech for K12 Educators (4 cr Cognate) also accepted GEN 2108		
EDUC 2231 Development of the Learner (4 cr ASD) or equiv PSYC courses (Dev/Life/Adolesc & Ed. Psyc; PSYC 100 prereq)		
Prerequisite to Entry: Grade of B- or better required	***Credits***	***Grade***
EDUC 2000 Gateway of NJ Teaching Profession (1 cr ASD)		

Additional requirements for EDUC entry*/placement		***Done?***
Attend Information Session and Orientation*		
3.0 or better overall GPA* ***GPA ______ as of ________***		
Criminal Background Check / Sub Cert		
TB Test		
Health Test or Nutrition Requirement		
Core Praxis Scores* or SAT score of 560+ reading & 540+ math or a 23 on both the English and Math sections	Reading score	
	Writing score	
	Math score	

#5 Professional Education Grade of B- or better required **(38 credits** counted at left) *Professional licensure courses may only be re-attempted once after withdrawal or failure to earn B- or better.*		
Clinical Experience Semester	***Credits***	***Grade***
EDUC 3100 Part-Time Clinical Experience in EDUC (50 hr, 2 cr ASD)		
EDUC 3105 Literacy Development P to Gr. 3 (3 cr ASD)		
PRAXIS II TEST(S) must be passed BEFORE the Clinical Practice 1 Semester in the subject(s) and grade level you wish to student teach. *Check this website for current NJ test information for certification area* *www.ets.org/praxis/nj/requirements*	***Score:*** Math- Sc- SS- LAL-	
Clinical Practice I Semester (formerly "Introductory Semester")		
EDUC 3101 Part-Time Clinical Practice in EDUC 1 (80 hr, 2cr ASD)		
EDUC 3200 Practices & Techniques of Teaching (4 cr ,ASD)		
Clinical Practice II Semester (formerly "Intermediate Semester ")	***Credits***	***Grade***
EDUC 4600 Part-Time Clinical Practice in EDUC II (W2)- *100 hrs* (2 cr, cognate)		
EDUC 4110 Methods of Teaching English Language Arts Literacy– Gr. 4-8 (2 cr, ASD)		
EDUC 4610 Curric. & Methods in Elem. Education (3 cr, ASD)		
EDUC 4150 Methods of Teaching Elementary Math (4 cr, Q2, cognate)		
Full-time Final Clinical Practice Semester (formerly "Student Teaching")	***Credits***	***Grade***
EDUC 4990 Full-Time Final Clinical Practice - *full-time 15-week experience* (12 cr cognate)		
EDUC 4991 Final Clinical Practice Seminar (2 cr ASD)		
EDUC 4992 EdTPA Capstone (2 cr ASD)		
In order for your certificate to be processed, you must meet the following requirements: complete your BA/BS degree; pass the Praxis test(s), take the EdTPA, and complete all liberal arts content coursework required; and attain a minimum GPA of 3.0. Final Overall GPA _____ as of ______		

The Liberal Arts BA with STEAM concentration is tailored to the student who seeks K-8 teacher certification and has an interest STEAM or STEM education. The degree blends all major K-8 content areas aligned with NJ learnings standards and the Praxis certification exam with an emphasis on mathematics & science. Additional coursework through a blend of program and general studies electives allow a student to explore the connections of technology and art to mathematics and science. By completing the degree as designed, a student can earn an initial endorsement in elementary (K-6) in addition to middle school specializations in mathematics and science (7-8). The degree also pairs well with several minors related to STEAM topics as described below.

Interested in studying more in art or earning an art minor? You will find many G course options well suited for this degree path that allow you to explore within art (see below for suggestions). Many of these can also contribute to a minor in art (indicated by a * in the sampling list below). For full details see the University Bulletin.

- GAH 1255 Fundamentals of 3-D Design
- GAH 1261 Fundamentals of Drawing
- GAH 2198 Sculpture, Geometry & Design
- GAH 2227 History of Photography*
- GAH 2286 Critical Theory & Contemporary Art*
- GIS 4617 The Image & The Eye

Interested in studying more in technology or earning a Digital Literacy minor? You will find many G course options you can opt to take that offer more exposure to technology topics (see below for suggestions). You can also earn a minor in Digital Literacy (indicated by a * in the sampling list below). For details see the university Bulletin.

- GEN 2108 Web Tools*
- GEN 2243 Exploring your Digital Portfolio*
- GEN 2260 Multimedia & the Digital World*
- GAH 2342 Living in the Digital World *
- GAH 2343 Visual Literacy*
- GAH 2403 Minds and Computers*
- GAH 3223 Intro to Digital Humanities *
- GIS 4618 Documentary Making Art of Fact *
- GIS 4623 Digital Culture*
- GIS 4662 Digital Storytelling*
- GIS 4663 Data visualizations & narratives*
- GSS 2430 Informational Intelligence *
- GSS 3146 Internet and Society *
- GSS 3148 Digital Media, Technology, and Society *

Interested in studying more in computer science or earning a minor in Information Systems/Computer Science? You will find many G course options well suited for this degree path that allow you to learn more about computing, computer science and information systems (see below for suggestions). You can also take additional CSIS courses to earn a minor in Information Systems or Computer Science. For details see the University Bulletin.

- GAH 2402– Minds and Computers
- GEN 2176– Mobile Application Use & Programming
- GEN 2260– Multimedia & Virtual Worlds
- GEN 3643- Cyber-security
- GNM 2139– Interactive Game Development
- GNM 2209– Intelligent Machines/Human Beings
- GNM 2248– Artificial Intelligence in Society
- GIS 3238– Cyber citizenship
- GIS 4642– Computing/Ethics in Cyber Age

Interested in studying more in math? You will find many different G course options well suited for you. Look for "Q1" and "Q2" courses within the G area. You can also earn a minor in mathematics by taking 5 MATH courses. See the Bulletin for more information.

Interest in studying more in science? You will find many different G course options well suited to you. You can also earn a minor in one of the branches of science.