Academic Program Review
External Reviewers

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Academic Program Review

External Reviewers Report Template

The report prepared by the External Reviewers will be used by the Arkansas Department of Higher Education (ADHE) to verify the student demand and employer need for the program, the appropriateness of the curriculum, and the adequacy of program resources. The report should not include a recommendation to ADHE on program continuation or program deletion.

The External Reviewers written report must include a summary of each area examined and should provide examples that document the conclusions. The questions below should be used by the reviewers as a guide in preparing the summary for each area. Responses to the questions should not be simply "yes or no".

I. Review of Program Goals, Objectives and Activities

A. Are the intended educational (learning) goals for the program appropriate and assessed?

The briefly stated program goal to "promote the development of professional scientists and mathematicians and provide opportunities for all students to enhance understanding of the natural sciences and mathematics" is appropriate for all mathematics programs nationwide. The specific inclusion of the service to non-mathematics majors, which is elaborated further in the full statement, is highly appropriate for mathematics programs in general and it shows the program's commitment to the University's full mission in addition to program specific goals. Courses "stress standards of communication, professionalism, technical proficiency, and teamwork."

The program's assessment of the achievement of technical proficiency through examinations in the courses seems to be without alternative. Mathematics happens in an individual's mind. So far, the best way to assess, as well as enforce, retention of focused content and the ability to use it, quaint as it may sound, is a proctored paper and pencil examination. The fact that advanced students are successful in nationwide standardized examinations such as the GRE and the PRAXIS II validates that the internally generated examinations are appropriate.

The capstone assessment focuses on students' ability to professionally master and communicate new mathematical content on their own. In the workplace, mathematics majors will always need to adapt so that they can interface with colleagues with more specialized training/positions, and to remain in step with advances in technology. It is exactly this adaptability that makes mathematics majors valuable to employers, and consequently this assessment is highly appropriate. A teamwork component would be interesting to consider for the capstone, but the requirement of mastery for every individual student is best enforced through individual projects.

The ultimate arbitrator of a program's viability is the employment and success of its graduates. Although there was a fad in the assessment community that tried to argue that successful placements may just be a measure of market demand, and although market demand certainly plays a role, a program that successfully meets definitive market needs can only be classified as viable.

B. How are the faculty and students accomplishing the program's goals and objectives?

Faculty and students follow the standard approach of transmitting content and skills through up-to-date classes in up-to-date curricula. Staying up-to-date requires the adjustment through new courses. One avenue for such curriculum updates, as indicated in the report, is to offer a new course first as a special topics course. In case of good resonance and success, such a course can become an elective or a required course.

C. How is the program meeting market/industry demands and/or preparing students for advanced study?

The program's three options are designed to meet current and future market/industry/societal needs by focusing on a classical path in the bachelor's degree, a growth path in the data science option and a high need path in the secondary education option. Preparation is achieved in all cases through a rigorous curriculum with appropriate requirements.

The traditional major prepares students for the traditional market for holders of a bachelor's degree in mathematics. The path that typically comes to mind is graduate school in mathematics. However, as is also evidenced by the graduates' career paths in Appendix G, the degree also opens opportunities for graduate school in other fields, such as education, the sciences, business and economics or professional schools such as law/medical/dentistry school. The nonacademic market for mathematics majors is typically and traditionally not well-defined. Few employers advertise for mathematics majors, but most employers will gladly hire STEM majors in general, and mathematics majors in particular.

The well-designed data science major is designed to meet an emerging industry need that would be a much larger part of industry if there were enough qualified individuals to fill positions. Over the last 25 years, computational tools have advanced data science from a novelty that only large corporations could afford, through being an enhancement for daily operations, to an absolutely needed subsector whose growth potential cannot be fully assessed even today. With the need for data analysis for daily operations already providing numerous opportunities for qualified individuals, the growth potential in this sector is best summarized by a statement one reviewer heard from a colleague: "Everybody has data, but not everybody has information." Clearly the opportunities for data science majors overlap with those of the other specialization. For example, actuarial science was and is a typical career path for mathematics majors. A career in actuarial science is available for students in any of the three tracks of the major, but the data science major is the best fit.

Finally, the new secondary mathematics major has the most well-defined career path: Students who prepare to become secondary school teachers can and usually will become secondary school teachers upon graduation. Because of the significant nationwide need for qualified teachers, which is driven by pending or already ongoing waves of retirements and an undersupply of new teachers to take their place, this program fulfills the most critical and most noble societal need.

The fact that the program does not require a minor indicates the commitment to producing graduates who can connect with any of the current and emerging societal uses of mathematics. Even a requirement of "any minor at all" would limit this ability. For example, before the data science option, students could have prepared themselves for the data science market by taking data science related courses in computer science, which now provides the "other half" of the curriculum, but also from economics, and, as available, biostatistics, geoinformation systems etc., leading to a collection that does not lend itself to a traditional minor. Clearly, if anyone could clearly predict similar growth areas for the future, they would do so. However, absent such vision, the preceding example regarding data science before it was a curriculum option shows that the flexibility granted to students is a positive feature.

D. Is there sufficient student demand for the program?

As indicated in I.C., there is significant market demand for the program's graduates. A total enrollment in the twenties is respectable for a local university. Moreover, it appears that the program is recovering from the adverse effects of the pandemic. Clearly, however, larger enrollment would be better.

To increase student demand, avenues should be sought to better explain the market demand and the attractive career features to parents of future students. In regard to the dire need for future teachers, with significant numbers of graduates becoming teachers in local schools, targeted recruitment of high school seniors who have strong local roots and who are interested in teaching may be a possibility. Possible avenues for such activities are the STEM contests, mathematics competitions and science fair activities that are held on campus and virtually, as well as through the Sigma Zeta Mathematics and Science Honor Society, Sigma Theta, and Mathematics and Physics Clubs.

The overall challenge is that, although mathematics majors are very versatile and typically successful in their chosen career, "mathematics" is not automatically associated with a recognizable career path, such as, for example "accounting," "journalism," "electrical engineering," and other fields that have an immediate association with a profession. This statement is also validated by the employment of program graduates in Appendix G of the program report, in which the only listed profession that includes the word "mathematics" is "mathematics teacher." The faculty is addressing this challenge through the data science track. Moreover, the new secondary mathematics track provides more visibility for a traditional field of employment.

E. Do course enrollments and program graduation/completion rates justify the required resources?

For any discipline that serves the university as a whole, and mathematics certainly is such a discipline, a resource analysis for discipline-specific programs must focus on the courses that are specific to the program alone, and it must exclude courses that the institution would need independent of, in this case, the mathematics BS programs', existence. Tables 2 and 6 clearly show that the resources that are dedicated specifically to

the mathematics programs are 2 courses per semester, a number that will increase to 3 courses per semester as the new secondary education option comes on line. While fully acknowledging that the upper level classes would benefit from larger enrollments, which can be achieved through growth of the programs, offering 3 options that are essentially separate bachelor's degrees at the price of one course per semester per option is a very good use of resources indeed.

II. Review of Program Curriculum

A. Is the program curriculum appropriate to meet current and future market/industry needs and/or to prepare students for advanced study?

As indicated in more detail in I.C, the program's three options are highly appropriate to meet classical, future and current needs.

B. Are institutional policies and procedures appropriate to keep the program curriculum current to meet industry standards?

Given that it was possible to develop a secondary education option as well as a very nice data science option for the curriculum in recent years, it stands to reason that policies are indeed appropriate.

C. Are program exit requirements appropriate?

Exiting with a capstone experience that requires the application of acquired skills and content in a new setting, and which also requires the acquisition of new content is highly appropriate for mathematics and data science majors: This is exactly the scenario in which employers will find these majors most valuable. Similarly, for the secondary education track, student teaching is the correct, and in this case, mandated, exit requirement.

D. Does the program contain evidence of good breath/focus and currency, including consistency with good practice?

The continuous improvement cycle to remain current and consistent with the current understanding is evidenced by the evolution of the curriculum. For example, the Python programming environment is on its way to become an industry standard, if it isn't already. Hence the recent inclusion of a Python programming course is keeping the program aligned with the state-of-the-art.

In terms of more traditional preparation, as a discipline curriculum in general, the mathematics curriculum has a feature that is rare, if it even exists at all, in other disciplines' curricula: Classes, such as Abstract Algebra, that consistently require students to produce correct mathematical proofs are, sensibly, because of the challenge they represent, taken in the senior year, maybe the junior year. However, unlike senior classes in other majors, these proof classes represent a complete paradigm shift from earlier classes. In most earlier mathematics classes, computational skills and good reasoning ability lead to success. This development of computational and reasoning skills takes time and they prepare students for their proof classes. However, the difference between

this, canonical and beneficial, preparation and the demands of proof classes is not comparable to the difference between, for example, a junior-level science laboratory and a senior-level science laboratory. In other disciplines, the skill set acquired in the first three years should lead to a senior year with few, if any surprises. In contrast, almost every new proof class a student takes entails almost a reset to zero in terms of directly applicable experience. [This comment is not intended to insinuate that the senior year is "easy" in other disciplines. Indeed all disciplines the reviewers are aware of place solid demands on their seniors. Rather the intent is to indicate the very unique position in which senior mathematics majors find themselves.] The program's requirement of an Introduction to Mathematical Reasoning class is a sound addition to the curriculum, intended to provide students a more solid foundation for proof classes. Additions of this type are still the state of the art and the best practice regarding preparation for mathematical proofs.

For the pedagogical component of the secondary mathematics program, currency is achieved through the required courses offered by the College of Education. These courses typically are synched with the current state and national requirements in education.

E. Are students introduced to experiences within the workplace and introduced to professionals in the field?

Because "the field" for mathematics is so broad, such exposure can be deemed either impossible, or, when a particular professional is introduced, as only a narrow slice of the broad spectrum of possibilities. For the data science focus, guest speakers from data science could be a possibility. For the secondary education majors, the workplace experiences will be built in through student teaching.

F. Does the program promote and support interdisciplinary initiatives?

The data science option as well as the secondary education option represent a modern as well as a traditional way for mathematics to connect with other disciplines. Their existence documents that the program indeed promotes and supports interdisciplinary initiatives. It should also be noted that the data science option is consistent with similar initiatives at other institutions, such as, for example, the Data Analytics option at Alfred State College.

G. Does the program provide respect and understanding for cultural diversity as evidenced in the curriculum, in program activities, in assignment of program responsibly and duties; in honors, awards and scholarship recognition; in recruitment?

Mathematical truth is uniform across all cultures and therefore equally accessible and fair in all cultures that provide access to education and that understand and respect the value of mathematics and science. With a faculty as small as at UAM, program assignments responsibilities are necessarily divided to use every individual's unique and diverse strengths. Information on honors and awards was not provided, and for small sized programs, annual awards may lead to default winners instead of being a recognition of

outstanding achievement. Regarding recruitment, to grow numbers it should be clear that students of all backgrounds will be welcome.

III. Review of Academic Support

A. Does the program provide appropriate quality and quantity of academic advising and mentoring of students?

During the site visit, students agreed that academic advising and mentoring are appropriate and appreciated.

B. Does the program provide for retention of qualified students from term to term and support student progress toward and achievement of graduation?

Conversations with faculty documented that faculty engagement strongly supports student progress towards graduation. Faculty appear to know all students by name and observed conversations indicate good rapport between faculty and students.

IV. Review of Program Faculty

A. Do program faculty have appropriate academic credentials and/or professional licensure/certification?

The Higher Learning Commission's minimum requirement of a Master's degree with 18 hours in the discipline taught (in case the Master's degree is in a different discipline) is satisfied by all faculty. All tenured faculty hold a doctoral degree. Thus all faculty hold the appropriate credential and many significantly exceed the minimum.

B. Are the faculty orientation and faculty evaluation processes appropriate?

Orientation and evaluation procedures follow typical academic patterns of start of year orientations/updates and end of year evaluation of activities.

C. Is the faculty workload in keeping with best practices?

A course load of 4 courses/12 semester credit hours is standard for tenured and tenure-track faculty without a research requirement. A course load of 5 courses/15 semester credit hours for instructors appears high, but may well be in line with the state's institutions' practices.

V. Review of Program Resources

A. Is there an appropriate level of institutional support for program operation?

Technical support, library resources and budget, computing equipment in classrooms, and the availability of instructional software and research grants are appropriate. The most computing intensive parts of the curriculum likely are the data science courses. Faculty are primarily using computing platforms that are supported on a student owned laptop. This systemic shift to low cost solutions that are readily available to students is a good alternative to providing large scale computer labs. This practice also raises

awareness of easily accessible resources, which is especially helpful to future teachers.

However, there also is a need to train students with proprietary software such as SPSS or MATLAB. The cost of software licenses for such programs essentially mandates that access be provided to students by the university. The annual cost of site licenses essentially mandates that individual perpetual licenses be purchased and installed on individual machines to which structured access is granted. These dedicated computers are most sensibly located in a dedicated lab. In this fashion, they are available to the students who need the specialized software, rather than being occupied by students using other programs that are more readily available.

The most precious commodity for a researcher is the time in which to perform the research, and the same statement holds for other pursuits, such as creating educational materials. Such time could best be provided through course releases. With a tenured/tenure-track faculty of 3 full time and one half time faculty member forming the core of the program, such release may not be possible because of course demand. However, this fact must then be taken into account as individuals are evaluated.

B. Are faculty, library, professional development and other program resources sufficient?

Resources, though they could always be more plentiful, are comparable to other programs with similar mission.

VI. Review of Program Effectiveness

A. Indicate areas of program strength.

Faculty engagement is high, as evidenced, for example, by a strong culture of using locally developed materials. Aside from high intellectual engagement, these products have a positive effect by lowering course costs for students.

From a systemic point-of-view, the courses that only serve majors in the mathematics programs are offered on a 2 year rotation. Therefore, per semester, there were only 2 courses specifically dedicated to the mathematics programs with all other courses being utilized by majors across the University. This figure will increase to 3 courses per semester with the addition of the education option/major. It must be pointed out that the cost of 2-3 courses per semester to service 3 separate options that essentially provide the equivalent of separate majors is as effective/lean as any program can be.

B. Indicate the program areas in need of improvement within the next 12 months; and over the next 2-5 years.

The primary focus must be on an increase in enrollment. It is not clear how a double major with the School of Education would enhance programs in either School.

C. Indicate areas for program development based on market/industry demands that have not been identified by the institution.

The institution has correctly identified the most significant market demands for mathematics majors in the long-term future. The current high need for teachers and data scientists can be expected to persist for decades to come.

VII. Review of Instruction by Distance Technology (if program courses offered by distance)

A. Are the program distance technology courses offered/delivered in accordance with best practices?

The program offers general education and elective courses in an online format if there is sufficient demand. The use of the Blackboard learning management system, the immediate feedback on homework problems, and the real time office hours reflect best practices for mathematics courses.

B. Does the institution have appropriate procedures in place to assure the security of personal information?

The security of electronically stored personal information is the purview of the University's IT support. Faculty will need to follow best practices regarding not disseminating sensitive information that is available to them, but this is standard operating procedure. IT's regular scans for inadvertently posted personal information are laudable.

C. Are technology support services appropriate for students enrolled in and faculty teaching courses/programs utilizing technology?

The fact that this institution, like so many others, has weathered a shift to a completely online environment in a matter of weeks in Spring 2020 strongly suggests that technology support is adequate. Online students are afforded standard enrollment/advisement/etc. services and all university business can be handled remotely by these students.

D. Are policies for student/faculty ratio, and faculty course load in accordance with best practices?

Please see part IV.C for course load overall. Regarding distance education, unless online classes are significantly larger than their face-to-face counterparts, counting an online class with the same weight as its face-to-face counterpart is best possible. The larger development effort for an online course is compensated with incentive payments, which is appropriate.

With all course sections being small, the student/faculty ratio is not a concern when it comes to student access to the faculty members. Indeed, the ability of faculty to provide focused support for students preparing for various admission exams indicates that the student/faculty ratio is favorable for students.

E. Are policies on intellectual property in accordance with best practices?

Faculty ownership of materials developed as part of their regular duties and with minimal institutional support is consistent with the long standing practice that textbooks are owned by the authors and royalties go to the authors. Similarly, for work specifically contracted by the university, it is standard practice that the rights remain with the university. The possibility of revenue sharing is an attractive feature at this institution and the applicable policy provides a multi-tiered system with examples given to take into account various combinations of faculty development based in individual initiative and institutional support.

VIII. Review of Program Research and Service

A. Are the intended research and creative outcomes for each program appropriate, assessed and results utilized?

For an instruction focused program such as this one, the appropriate outcomes from creative activities are any and all enhancements of the student experience. The strong culture regarding locally developed materials evidences that results of such developments are utilized. Their assessment is then part of the annual evaluation of teaching performance.

B. Are the intended outreach/service/entrepreneurial outcomes for each program's initiatives appropriate assessed and results utilized?

Future outreach outcomes should focus on recruitment, the assessment of which would be the number of additional students recruited to the institution and additional majors recruited to the individual programs. The biggest service outcome for a mathematics department is the provision of strong service mathematics courses for the whole university. These courses are then assessed annually in faculty evaluations as well as in curriculum analysis. Because of the breadth of fields into which mathematics majors can enter, entrepreneurial targets would unnecessarily restrict the focus.

IX. Local Reviewer Comments

A. How is the program meeting market/industry demands and/or preparing students for advanced study?

Local reviewer comments are consistent with comments given here. The program is designed to meet the indicated needs.

B. What program modifications are needed?

Local reviewer comments are consistent with comments given here. The most significant need is an increase in enrollment.

X. Report Summary

A. Include reviewer comments on the overall need for program graduates/completers in the local area, region and/or nation over the next 5 years.

There will always be a use for holders of a bachelor's degree in mathematics, even if this need is not manifested in a well-defined career path or area. The current and future need for data scientists is high in any branch of modern life that relies on data. Finally, the need for secondary mathematics teachers is dire throughout our region. Hence, there definitely is need for this program's graduates.

B. Include reviewer comments on overall program quality, state program review process, etc.

The programs are well designed and effective. With the review process, sensibly, designed to apply to all programs at all institutions throughout the state, it must be emphasized that mathematics programs are fundamental to the functioning of any institution. Most courses must be offered to serve other majors, independent of program specific needs. In the case of this department, 3 degree options are offered at the real cost of 3 courses per semester. It would be hard indeed to find a more effective offering of a degree with so many options.

Academic Program Review

External Reviewers Report Template

I. Response to the External Reviewers' Recommendations

In this section, please copy the recommendations that the external reviewers provided in their report. Then, provide the institution/department/program response to the recommendation.

Recommendations from External Reviewers (copied from the external review report)	**Response**

Academic Program Review

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I. Actions Taken in Response to the External Reviewers' Recommendations

In this section, please describe the actions that will be taken as a result of the review; if any based on the recommendation from the external reviewers; note when the action will be completed and who is responsible for seeing that it is completed; and finally, list any resources that will be used to complete the action. Please add lines to the table as necessary.

Recommendation	**Action**	**Timing & Responsible Person/Group**	**Resources**