

## Definition of Undergraduate Research

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There are three definitions or sets of defining characteristics for undergraduate research that have been put forward that can guide discussion on the matter.

The first was developed in 1997 at a dialogue session entitled “What Constitutes Undergraduate Research” at the April Dialogue conference put on by the Council on Undergraduate Research (1,2).

*Undergraduate research is an inquiry or investigation conducted by an undergraduate that makes an original intellectual or creative contribution to the discipline.*

There are several features of the definition that make it a particularly suitable description of undergraduate research. It does not force scholarship done by undergraduates into one model, thereby permitting flexibility among different disciplines. There is no judgment made on the relative value of faculty- or student-initiated work. Both are equally acceptable. The definition allows for student-faculty and student-student collaborations when undertaking the research. The definition sets forward a high standard, since it maintains that scholarship must be original and that it must contribute to the discipline. Undergraduate research projects must be designed with the intent of creating new knowledge. Requiring that the research contribute to the discipline implies that the work be disseminated among the relevant community through established means and that others in the discipline value the findings. A goal is to present the results of the research at conferences and eventually publish the work in peer-reviewed journals.

The second was developed by the American Chemical Society’s Committee on Professional Training (3). They described the following as characteristics of undergraduate research.

*Research is the development of new knowledge or understanding in order to advance science. While the specific areas of research vary immensely in the chemical sciences and in chemical education, there are some traits that are common to undergraduate research in general. Undergraduate research is conducted with a faculty advisor or mentor. The student’s research project is typically based on the faculty mentor’s research interests, an arrangement which allows the student to draw upon the mentor’s expertise and resources and also allows the faculty mentor to develop a productive research program. The mentor meets regularly with the student to make research plans, assess risks associated with the proposed research, and review results. The student is encouraged to take primary responsibility for the project and to provide substantial input into its direction. The student-mentor relationship also builds student confidence, offers encouragement when necessary, and provides guidance and assistance for the student’s future education and career development. Undergraduate research should be envisioned as publishable in a peer-reviewed journal. Research builds upon the previous*

*accomplishments of other scholars. For research to have any meaning or effect, it must be communicated to the scientific community. Peer review is the generally accepted means of monitoring and ensuring the quality of research. While not every undergraduate research project will result in a peer-reviewed publication, it should be the intent of each project to contribute to such a result. When an individual student research project is not of wide enough scope for an entire publication, it can often be combined with other undergraduate research projects into a more comprehensive study that merits publication.*

*While the nature of each project depends on the specifics of the research, an ideal undergraduate research project:*

- \* has a clearly communicated purpose and potential out-comes,*
- \* has well-defined objectives and methods,*
- \* is substantial in scope (as opposed to a collection of small projects),*
- \* has a reasonable chance of completion in the available time,*
- \* requires contact with the chemical literature,*
- \* avoids repetitive work,*
- \* requires use of advanced concepts, and*
- \* requires a variety of techniques and instruments (not exclusively library work).*

*Finally, undergraduate research should culminate in a comprehensive written report. Oral and poster presentations are an extremely useful step in this process. However, a research project should not culminate solely in an oral presentation, as it would not become part of the archived body of knowledge. A written report adds to the permanent scientific knowledge base and can be used by subsequent researchers pursuing related projects.*

Similar to the first definition, these characteristics require that the work be original and that the work be disseminated to the scientific community. The ultimate goal, although it often may not be realized when working with an undergraduate, is to publish the work in a peer-reviewed journal.

The third definition is one that Art Ellis, who is currently the Director of the Chemistry Division of the National Science Foundation, has used in recent talks (4). He describes the idealized undergraduate experience as being based on two features, creating and communicating knowledge, and then identifies five activities done within each of the features. The activities involved in creating knowledge map only the activities involved in communicating knowledge according to the conventions of chemistry publications.

*Create Knowledge*

*Context*  
*Experimental Design*  
*Experiments*  
*Interpretation*  
*Peer Review*

*Communicate Knowledge*

*Introduction/references*  
*Experimental section*  
*Results*  
*Discussion*  
*Presentation/publication*

There is an appreciation that undergraduates may not, in the relatively short period of time they participate in research, be involved in all five components of the project. For example, in most instances an undergraduate student does not develop the context for the project, and instead works on an idea that was generated by her or his faculty advisor. Similarly, many undergraduates do not get to see their work all the way through to publication. Some work never gets to the point of being published. Other work is often published after the undergraduate has left the project. Nevertheless, the understanding that undergraduate research involves original work intended for publication in peer-reviewed journals is an essential component of this definition, just as it is for the first two.

An important question to ask is why each definition is consistent in requiring that undergraduate research be original, such that the ultimate goal is to create new knowledge. There are people who contend that the only goal of undergraduate research that really matters is student learning, and that undergraduate students can often learn just as much science by conducting an investigative project, regardless of whether the outcome is already known. What is it that distinguishes original work as a learning experience from having an undergraduate student conduct an investigative project on something that is already known? The answer hinges on the supposition that it is more difficult to create knowledge than it is to learn something that is already accepted by people in the field. If so, then creating knowledge has the potential to take learning to a heightened level.

The creation of new knowledge requires an exceptionally high level of proof, and is an incredibly exacting enterprise. The persons conducting the research must be able to unflinchingly convince an audience of peers that the new knowledge is valid. Creating knowledge requires a special persistence and attention to detail because the real answer is not known, many experiments will not work as originally planned, and success will ultimately depend on the skills of the investigator(s). With original work, there is no place to go for the definitive answer. Being the first person to know something has the potential to create a tremendous sense of empowerment, confidence and intellectual growth, especially for undergraduates who have usually never had such an experience. Since people will continually encounter problems without established answers throughout their life, the skills gained through participation in original research aimed at creating knowledge have long-lasting, beneficial consequences.

## References

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3. "Characteristics of Undergraduate Research," *Committee on Professional Training Newsletter*, Spring **2002**.
4. "Report on CUR Dialogue," *Council on Undergraduate Research Quarterly*, **2003**, *23*, 174-175.