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**Developing Undergraduate Student Research Experiences  
in Operations Management**

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## **Developing Undergraduate Student Research Experiences in Operations Management**

This paper describes the efforts underway at the University of Dayton to provide research experiences for undergraduate students in Operations Management. The aim is to infuse an attitude of lifelong learning, to sharpen students' objectivity, enhance their ability to search and filter relevant information, and improve their writing and oral presentation skills. As part of a semester course in Supply Chain Management Strategies, students choose a topic from a prepared list of suggested topics and related research questions. Students are provided guidance on what constitutes good research and writing, and given timely feedback in one-on-one status meetings. Project results are disseminated via a 'student research conference', attended by fellow students, faculty, and regional business people. Initial experience with this format has been positive. Already after the first year, one research paper has won a national student paper competition.

# **1 Undergraduate Research in Business Education**

## **1.1 Starting Position and Motivation**

Student involvement in research activities in U.S. business schools has been traditionally restricted to graduate (masters, PhD) students under the tutelage of faculty advisors. One can cite numerous examples of undergraduate research involvement in schools of science and engineering, but in schools of business administration, such involvement has been minimal. Consider for example the National Science Foundation's (NSF) highly visible "Research Experiences for Undergraduates" (REU) program, which supports active research participation by undergraduate students in any of the areas that NSF funds. As of 2006, NSF devoted an annual budget of \$33 mil to this program. Of the 1,000 active awards it was supporting none of them were to U.S. business schools.<sup>1</sup>

As the NSF describes, research experience is one of the most effective ways for attracting and retaining talented undergraduates to careers in science and engineering, including teaching and education research. We take the position here that this is just as valid for attracting talent to the fields of business administration. In the Carnegie Foundation's well-publicized Boyer Commission report, *Reinventing Undergraduate Education: A Blueprint for America's Research Universities*, one of the main recommendations for change in undergraduate education is "to make research-based learning the standard". The report cites numerous examples of where this philosophy is already well entrenched. A notable example in business administration is MIT's application of their university-wide Undergraduate Research Opportunities Program (UROP), which has involved undergraduates in research topics such as studies of competition in telecommunications, the effects of taxes on corporate decisions,

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<sup>1</sup> See [http://www.nsf.gov/funding/pgm\\_summ.jsp?pims\\_id=5517&org=NSF](http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5517&org=NSF)

and the impact of direct foreign investment on developing economies.<sup>2</sup>

There are numerous articles in the pedagogical literature that highlight the benefits of undergraduate research. Some interesting examples include Chang (2005), Gibbs (2005) and Hake (1998).<sup>3</sup> There are also caveats. For example, in the aforementioned UROP program at MIT, experience has shown that instructors must adjust the research requirements to the appropriate level of students, especially when introducing the program at the very beginning of undergraduate courses (see Lewis, 2006).

## **1.2 Pedagogical ‘Strategy’ - Turning Constructivism into Practice**

In a ‘traditional’ class those pupils who passively soak up everything the teacher might serve up to them in a suitably ‘didactic sauce’ only to ‘spout it’ back word for word, are regarded as industrious. This teaching style was recently used as an image in the TV-advertisement of ‘Butterfinger’.

Undergraduate research in which every student of a class develops ideas on their own topic obviously requires a modified teaching ‘strategy’, which could be summarized with the following key features:

1. *Context:* Learning is efficient when embedded in a situated context (e.g., Brown, 1989). A student’s interests, background and culture drive his or her decision to select

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<sup>2</sup> See <http://econ-www.mit.edu/under/majors.htm>

<sup>3</sup> Integrating research into the business curriculum is not unusual in Germany. E.g., we know that in the Bus. Inf. Systems I Dept. at the University of Erlangen-Nuremberg, the paradigm ‘research through prototyping’ has been a success story for decades, and is a practice that König, Heinzl, and von Poblitzki (1995) found to be widespread in German speaking universities.

a topic and develop it further. An undergraduate with International Business as a co-major is likely to choose a topic like ‘Setting up a Sourcing Organization in China’.

2. *Nature of the student:* The student’s role does not comprise any longer data collectors, number crunchers or end-to-chapter calculators. The learners are actively involved in filtering information, and giving articulate form to their knowledge. At final presentation they listen (and learn) from others using their language. Conversely, this new role requires to identify own knowledge gaps and to monitor own learning progress.
3. *Nature of the teacher:* The role of the instructor shifts from pure presenter to facilitator, motivator, enabler, coach and reviewer. He observes less and instead promotes critical reasoning through asking questions, pointing out alternatives or even expressing doubts. Students learn for research and research for learning. The interaction means that student also discovers the instructor’s subjective views on culture, values and backgrounds. Of course, this kind of teaching role is not new: the famous Prussian scholar of the German enlightenment, Alexander von Humboldt saw himself not as a teacher at the blackboard but as a ‘researcher-teacher’.

The result is that the students construct their own personal ‘world of knowledge’. This is also called the starting point of ‘constructivism’ (see at length Duffy and Cunningham, 1996; Hewson, 1981; Magoon, 1977; Osborne and Wittrock, 1985; for a critique of the use of constructivism in education see Scerri, 2003). There are, however, subtle nuances we cannot deal in this article. For example, the theory of situated learning is seen in German literature as connected with the discussion of constructivism, albeit less so than in English writings.

Given this background, we now turn to describing our specific efforts at the University of Dayton (UD).

## 2 Undergraduate OM Research at the University of Dayton

The University of Dayton offers undergraduate research within its Operations Management (OM) program. It constitutes roughly 30% of the semester schedule of, a final course for students in the fourth year. Circa 40 working hours are allocated for the active research experience for each student. This is not our first adventure in undergraduate teaching style. For example, we have been following a problem-based learning approach in other parts of the course already for several years (see Kanet and Barut, 2003; Kanet and Stöbblein, 2007).

Integrating research and education, we aim to enhance the management knowledge of the learners. They become acquainted with the role of Operations and its relation to other key business functions (e.g., Marketing, Finance) as well as with fundamental OM-concepts. With undergraduate research we try to develop the following skills in students:

1. *Critical thinking*: Students will sharpen their objectivity and learn how to distinguish between significant and less important facts. Thus, their ability to search fast and filter relevant information is enhanced. This helps them to critically evaluate and analyze, for example, how Operations decisions affect a firm's financial and market performance. For a comprehensive list of more than 30 dimensions (of critical thinking) see Paul, R., Binker., A., Jensen, K., H. Kreklau et al. (1990).
2. *Performing original research*: Students gain insight into a scientific problem and try to find solutions under guidance while applying management science methods (e.g., mathematical programming) to operations problems. To put it into a nutshell, they learn how to analyze the state-of-the-art, conduct simulations, make plausible inferences or even develop hypotheses.

3. *Preparing a professional research report and presentation:* Individual coaching aims to improve their writing skills and strengthen their fight against superfluous words. It helps to clarify words and to structure reports, e.g., avoid writing two thirds of a paper only about problems. Actually, several surveys show that companies complain about the weak writing style of young professionals (e.g., The National Commission on Writing (2004) surveyed 120 human resource directors).

Our students have the unique opportunity of specializing ‘just-in-time’, i.e., some weeks before graduating, on a topic of their interest and choice respectively. The advantage of a successful completion is to get a ‘jump-start’ not only on their first job position but also the experience of acting independently, practicing a good work ethic and life-long learning. It could even serve also as a differentiation feature in their curriculum vitae. Up to our knowledge no other business school offers undergraduate research experience for all students in Operations Management.

The following chronicles the efforts underway at the University of Dayton to provide active research experience for undergraduate students in Operations Management. Students are supported at every stage of the research experience life cycle.

## **2.1 Planning**

Particular attention is paid to the OM-related research projects, which are specially designed for the purpose of the course. Thus, they have a well-defined common focus, a strong intellectual emphasis, and show relevance either in research or in practice. The majority of topics are adjusted to the knowledge level of students. However, we also developed some quite challenging themes, e.g., in regard to advanced methods such as AHP (Analytical

Hierarchy Process) and ARIMA (Autoregressive Integrated Moving Average Model), and consequently were positively surprised such topics were also among those students chose.

To get a ‘jump start’ we added possible research questions and primary sources (Figure 1), e.g., books and scientific articles, which we checked for online availability or in the university library. Thus students could immediately focus on heading for research results without expending time thinking of a topic. They do, however, are expected to polish and redirect the suggested topic, of course with their own slant/interest, title, and specific research questions.

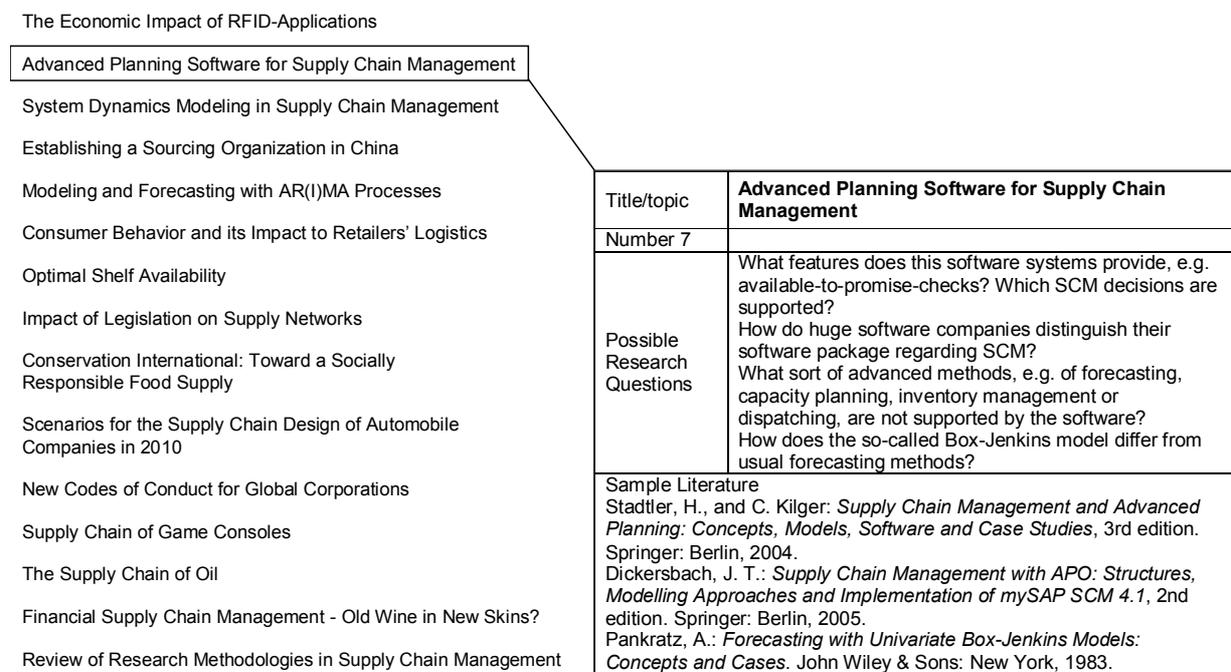


Figure 1: Selected Raw Titles and a ‘Topic Card’

In order to assure that each student gets the topic that is best for him, we consider their preferences on topics, i.e., they rate up to 9 preferred topics on a scale from 1 to 9 (highest preference). 18 students could choose one out of 50 research projects. The allocation of topics to students is solved by optimization with linear programming.

The student research is independent from funding. This follows Humboldt's idea that universities should remain free of state patronage or any other constricting conditions.

## **2.2 Coaching**

At the very beginning, students receive a compact manual which includes tips for their research in regard to content, formalities, presentations etc. Our objective was to provide guidance which is as easy to understand and as pragmatic as possible without neglecting research requirements. The simplest solution is checklists. Here they will find several points crop up frequently such as style, since we have observed that despite business writing courses at the university the ability to express themselves is deteriorating - a possible result of current text messaging and Messenger style.

Whilst in the undergraduate research course we have incorporated certain theoretical foundations and even indicated some of the ongoing discussions in the scientific community, e.g., the rigor versus relevance dilemma, we have at the same time not delved too deeply. We reasoned that too much of a good thing could dampen the enthusiasm of many. In this regard we do not cite the albeit valuable 'exegeses' of Popper (*The Logic of Scientific Discovery*) or methodological issues, which are often offered as a tutorial in doctoral sessions of conferences. Due to the limited time of the students, we do also not foster the idea of collaborative research with industry partners. Notably, students share such an experience in capstone projects of the same chair.

### **2.2.1 Getting Started**

Starting as soon as possible is crucial, in order to clear the first hurdle of research, namely actually getting the first lines down on paper. Our suggestion is therefore to ‘google’ the list of ideas provided in the list of projects and to consult the instructors with the research paper progresses without waiting for any deadlines.

Another important issue for a ‘jump start’ is to research in the right places: Textbooks and end-of-chapter references to source documents are very good starting points. Another great help is provided by the Business Source Complete, Factiva, Gartner databases. In the appendix of the students’ manual several screenshots illustrate how to use such electronic resources. Also provided is a list of useful publications like Harvard Business Review, Journal of Supply Chain Management, Production and Operations Management, and Manufacturing and Service Operations Management. For some projects, periodicals like the Wall Street Journal (WSJ) may be particularly useful. As UD is academic partner school with the WSJ, UD students receive not only the paper-based version but also have access to the online edition.

### **2.2.2 Doing Good Research**

Students receive in their manual some ‘rules of the game’ that give guidance to what constitutes good research based on the research experience of the authors. We distinguished between ‘content’ and ‘formalities’.

An important research goal regarding content is the strength of inference achieved in the research study (rigor) which is more than just the ‘quantitative or statistical significance of the study. Relevance is brought to the fore so that students also have to ask themselves

whether a finding or idea contributes to the advancement of knowledge, e.g., for a private sponsor? The depth of analysis is also an essential factor. For example, a state-of-the-art analysis in a research paper should discuss what is known and assembles the findings in the research area. Results of this step are ‘white spots’, i.e., gaps in research, which warrant filling. Finally, it is not infrequent that we have to draw attention to the accuracy of work, i.e., to avoid errors in reasoning.

Formalities are a second ‘success factor’ for research. Students are advised to use precise expressions, to clarify terms, especially technical ones, in order to cope with the inflation of TLAs (Three Letter Acronyms). In comparison to medicine and law, we view it as the drawback of the social sciences - that terms are increasingly ‘(re)invented’. Unfortunately, this has led to a blurring of language. To give an example: for many years we taught ironically that ‘IGSCM’ could be the ultimate development of our domain. On a visit to a corporate project partner we were astonished to find that ‘Intergalactic Supply Chain Management’ was already in use.

Finally, the written work of students should be easily understandable, comprehensible and readable to practitioners and academics (language) and, moreover, introduction, body, conclusion be clearly evident (structure). We follow Popper’s remark: “Wer es nicht einfach und klar sagen kann, soll schweigen und weiterarbeiten bis er es klar sagen kann” (He who is unable to express something simply and clearly should remain silent until such time as he can).

### **2.2.3 Meeting the Instructors**

In order to follow students’ progress and to give timely feedback, regular (bi-weekly) meetings are held. We encourage students to present their research proposals, table of

contents and any other results. The interaction helps to develop ideas, to think in different directions or to assist students to stay focused on the topic.

#### **2.2.4 Ensuring Quality**

The research assignments consist of the following deliverables. In each case a how-to-do-it checklist is provided.

1. *Research proposal*: This is a short (3-4 -page) document that clearly identifies what the research is about. Students are encouraged to think of it as the beginning skeletal version of their full paper. What makes a good proposal? At least a good title, an informative abstract, a substantive outline, a substantive set of references and a correct format. In our checklist we clarify each factor in more detail. For example, to understand what is an informative abstract and how it compares to a descriptive abstract and executive summary we illustrate with examples and refer to details and examples found in Finkelstein (2005).
2. *Final paper*: This document contains research results summarized in about 4,000-6,000 words (excluding figures, tables, appendices, and references). What should a learner consider when writing a good final paper? As a guideline we suggest paying attention to the following: liberal use of clear titles and sub-titles, the existence and development of a theme, a good introduction, the appropriate use of facts and figures, examples and illustrations, style, structure, quality references, ‘attention to detail, having someone comment on your first draft, using the available word processing tools, and avoiding unnecessary quoting. For example, a good introduction has many of the following properties: it provides relevant background and describes the

problem(s)/issue(s) addressed by the paper; it explains the main purpose of your paper; it provides evidence as to why the problem/issue is important; it describes the benefits/contribution that the paper provides; and it outlines how the balance of the paper is organized. In order to learn from mistakes, we list “bloopers” that we found in former research papers, such as: “These costs can be very costly to a company who is trying to reduce costs and will be described in detail later in the paper.”

3. *Abstract page:* As an aid to making the oral presentations more meaningful for everyone, students have to prepare an ‘abstract page’ as per a sample found in the students’ manual. These pages are then assembled into a student research conference booklet.
4. *Final presentations:* Each student delivers an oral presentation of his research. We therefore give a reminder of some of the factors that make for quality presentations. The checklist consists of tips regarding organization, presentation aids, delivery (including speech, voice, gesture, and body language), question and answer period.

In regard to working hours and expectation, we decided that final papers should be about 4,000-6,000 words long (excluding figures, tables, appendices, and references) and abstract pages about 250-350 words long. Since students were already taught in their business writing courses the MLA (Modern Language Association) approaches for formatting and references, they are directed to apply the same rules in their research papers.<sup>4</sup>

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<sup>4</sup> MLA offers a noteworthy solution for how to quote Internet references by mentioning both the date of publication and of access.

### **2.3 Evaluating**

Not only the instructors but also the students to a certain extent evaluate the research. The grading schemes which are published in the students' manual consider for example to what extent the objective/purpose of the paper is made clear in the introduction (written work), or to which degree the oral presentation was clear, audible and professional. Every student completes an assessment of the speaker after each final presentation. We collect these assessments and tabulate the results. In order to avoid any bias, we explicitly point to the fact that these assessments are not used in formulating a student's grade. Rather, they are used to decide a 'students' choice best presentation award' given at an awards ceremony at semester's end.

### **2.4 Submitting**

Students have to submit their results electronically to [www.turnitin.com](http://www.turnitin.com), a web-based uploading service for students' papers. The advantage of such services is that they not only facilitate evaluation of the works electronically, but they also detect plagiarism through use of text mining techniques.

### **2.5 Disseminating Students' Findings**

We are convinced that the intellectual merits of fourth-year students' findings are often valuable to both academics and practitioners. Therefore, we give students the unique opportunity to present their results before a greater audience than just their course classmates. The projects culminate in oral presentations to an audience of students, faculty, and invited

guests from the regional business community. The best student also speaks at the University's annual research symposium. We do this in part to increase their motivation and help promote their self-confidence. In addition students are encouraged to participate in students' paper competitions (described below).

Essentially, project results are disseminated in two ways:

1. *A student research conference:* The final presentations are held at a 'student research conference'. Four successive lecture dates are reserved for three to seven presentations of 25 minutes (including discussions). The presentations for 2007 are structured in the following five tracks:

- How to Cope with Supply Chain Risks - A Glance at Legislation and Disasters
- Economic Perspectives on Supply Chains - Free Trade and Microcredit
- Going Global? Targeting China, Africa, Europe, Japan, India
- The Influence of Information Technology on Logistics
- Supply Nets in Selected Industries and Business Types

The student research conference is announced through showcases and posters in the university as well as newsletters and individualized invitations per email to fellow students, alumni, and members of the faculty. Moreover, a conference booklet is made available to members of the OMAC (Operations Management Advisory Council), to partners of the Operations Management capstone projects and to selected regional business people as well as to potential employers who are in contact with the department. Personal invitations are also issued to certain industry representatives. The conference booklet includes not only a short foreword, the program (tracks, topics,

time schedule) and submitted abstract pages but also a brief biographical sketch and contact data of the students. Thus, any interested companies can contact the students at any time.

2. *University Research Symposium*: Fostering an atmosphere that nurtures productive collaboration and a shared quest for excellence in learning and in research, the Bro. Joseph W. Stander Symposium is celebrated every year at the campus. It demonstrates the Marianist tradition at the University of Dayton: education through community. As an alternative day of learning, students of all faculties present posters, lead conversations, participate as members of a panel discussion, perform or display a piece of art and have the opportunity to network with colleagues, faculty and business leaders. Marketing is taken care of by the University. Each year the individual research projects in Supply Chain Management are showcased at this symposium (through a poster display and selected presentations) as examples of research in business administration.

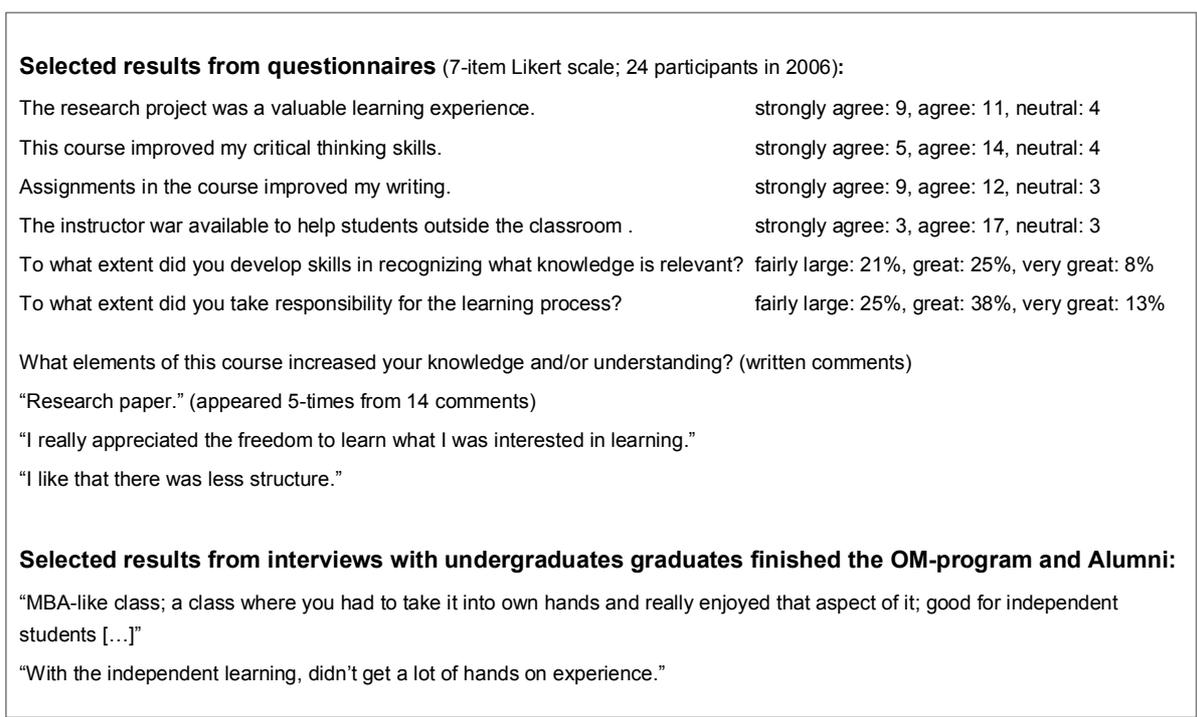
### **3 Assessment**

The objective of assessment is the continuous improvement of the undergraduate research experience and the determination of the degree of student learning that has been achieved. Assessment involves periodic measurements during and after the course.

#### **3.1 Students' and Alumni Feedback**

Feedback is collected for the Supply Chain Management Strategies course via peer review in

several ways. We target not only current course participants but also alumni because we aim to assess the level to which the undergraduate research experience has been a lasting impact on an individual career path. We developed a specific end of semester course questionnaire as well as question sets for administration to graduating Operations Management students and alumni. Figure 2 illustrates selected early results.



*Figure 2: Impressions of the Student’s Feedback*

Preliminary results indicate that the research assignment tends to improve the student’s skills set we were originally aiming at, namely inter alia, critical thinking and writing skills, and information filtering abilities. According to the survey results, undergraduate research generates knowledge and understanding of Supply Chain Management Strategies, and has proven to be a significant course element. It is worthwhile mentioning that we did not find any

written comments about a necessity for improving the research format. Although this seemed very pleasing we continuously refined the research experience from semester to semester.

This constructivist teaching ‘strategy’ appears to be effective because the students feel a very strong responsibility for their own learning process. Though some participants are in favor of independent research, some didn’t appreciate this teaching design. However, our future surveys will show more results on this.

### **3.2 Awards of Student Paper Competitions**

We encourage students to participate in student competitions, e.g., provided by National APICS (The Association for Operations Management) or CSCMP (Council of Supply Chain Management Professionals). The students’ manual gives a guideline how to submit papers. Winners receive cash awards, are featured in the relevant organization’s publications, or get a trip paid to an annual conference. If a student shows proper evidence that they have sent their paper to these organizations, s/he receive a certain amount of added points. Already after the first year, one undergraduate won APICS’s national student paper competition for the research project ‘CPFR: The Sharing of Information within a Supply Chain’. By and large, the course design could be a feasible way to attract the one or the other talented undergraduate for a career in academia and Operations Management respectively.

### **3.3 Instructors’ Observations**

During the semester, the instructors collected their own impressions. Although some remarks are not terribly remarkable, we will mention them for completeness’ sake (Figure 3):

**Selected observations:**

The majority of students seem to be enthusiastic about doing research - their efforts and progress demonstrate they feel quite satisfied with their chosen research topic.

Some students work only from deadline to deadline.

Students show deficits in coping with deadline issues, i.e. not all students uploaded their abstract pages on www.turnitin.com as requested on their checklist but sent them to our secretary.

Students appreciate the honest feedback in their final presentations given by friends and colleagues.

Even though students got a compact student manual, the instructors still received inquiries e.g. about formatting and similar.

*Figure 3: Selected Impressions of the Instructors*

## **4 Conclusion and Further Developments**

Initial experience with active undergraduate research in Operations Management has been positive in recent semesters. This impression is derived from the learned skill of performing research, the gained knowledge of Supply Chain Management strategy and feedback from students, alumni, and external observers. Especially impressive was that one student won a paper award at a national student's paper competition. Given these indicators, it is reasonable to conclude that this teaching 'strategy' seems to be effective. However, the time requirements demanded of the instructors to motivate students, to facilitate learning, and to be available for student mentoring is by no means negligible. Although we have not attempted to measure this effect, the undergraduate Operations Management research experience might have the effect of recruiting young scientists for advanced (graduate) study in business administration.

In our efforts to continuously enhance the unique enriched research experience for students and thus help to sharpen the profile of the Business School at the University of Dayton, we are contemplating the following enhancements: compact writing sessions for developing research questions and abstracts; presentations of essentials in research methodology;

enlargement of the student research conference experience with support from sponsors; and development of a frequently-asked-questions dashboard on the course website.

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