Teaching and training operations research in Jordanian Universities: an empirical study

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Abstract: This study evaluates the current status of the teaching and training of operations research (OR) in Jordan. The aim is to explore the objectives, topics covered and methods employed in teaching OR courses. It assesses the suitability of the courses to the needs of decision makers and the difficulties encountered in delivering the courses. Two questionnaires were employed. The first was directed to all educators teaching OR courses within all relevant Jordanian Universities during the summer semester 2003. The second was presented to 168 students who were studying OR courses in a random sample of six Universities. It is concluded that OR education in Jordan does not satisfy the needs of decision makers. Some of the problems identified in OR education is the relevance of the curriculum, lack of local teaching materials and specialised personnel, lack of training programmes and computer usage.

Keywords: developing countries; education; Jordan; OR; operations research.


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1 Introduction

Education is an essential element in developing human resources. It plays a key role in a company’s progress and competitiveness. The availability of operation research (OR) scientists depends on education. Higher-level education programmes should be available to create new skills that are required in a continually changing environment. The task of educators is to create consistent programmes and strategies of learning in order to cope with the problem opportunities being faced. Developing countries are increasingly becoming aware of the need for better education in management and related disciplines. This may enable them to cope with competition and development challenges.

Many studies, some of which are empirical in nature, have discussed the education of OR in both developed and developing countries. There has been work in this area in the USA (Carraway and Freeland, 1989; Cox et al., 1978; Gallagher, 1991; Gunawardane, 1991; Strasser and Ozgur, 1995) in the UK (Beasley and Whitchurch, 1984; Mingers, 1991) and in Hong Kong, Japan, Korea and Taiwan (Kao et al., 1997).

In addition to the previous studies on OR education, there are other relevant works. These are non-empirical in nature and cover topics such as the framework for teaching OR (King, 1988) and its use in an undergraduate curriculum (Bailey and Weal, 1993). There are papers on apprenticeships (Bennett and Macfarlane, 1992), learning the practice of OR (Eaves, 1997) and teaching OR with case study methods (Bell and Lanzenaue, 2000; Bodily, 1996; Cochran, 2000). There are also studies discussing the teaching of OR methods, which focus on managerial relevance (Carraway and Clyman, 1997), the use of spreadsheets (Cragg and King, 1993; Gass et al., 2000; Grossman, 1997; Leon et al., 1996; Winston, 1996), against the importance of the use of spreadsheets (Groleau, 1999) and also the teaching of communication in an OR course (Keller and Kros, 2000). Other studies discuss the teaching of OR using microcomputers (Erikson and Turban, 1985; James, 1988; Zanakis et al., 1991) and the use of multimedia materials for teaching OR (Belton et al., 1997; Daellenbach and Petty, 2000; Simpson and Edwards, 2000).

Much debate over OR education has been confined to the relevance of the content and style of programmes at the postgraduate level (Mingers, 1991). However, there is relatively little that describes teaching and learning processes that might be used in sufficient detail to provide role models. Recent contributions in this area are Bennett and Macfarlane (1992) on the use of short work placements during a course, Weal (1991) on incorporating practical elements in an undergraduate rather than a graduate setting. This was updated by Bailey and Weal (1993) to cover teaching techniques used in such courses. Belton and Scott (1998) added to this important area by providing further case studies, supported by the philosophy of independent learning in OR education. It is worth noting that the previous studies are useful, in that they provide examples of teaching techniques to be employed by educators. Sagasti (1972) and Walsham (1978) suggested that OR programmes should be offered at a postgraduate level. They preferred a master’s level course for OR practitioners who intend to work in industry or government. Dando and Sharp (1977) and Affleck et al. (1987) advocated greater care in the selection of students for this level of training. Much has been written about the decline of OR and Management Science (MS) education, particularly in MBA programmes (Liberatore and Nydick, 1999). Some researchers have given recommendations to improve the quality of OR education. They suggested changing in a radical way the delivery of the primary
MBA course in OR. The most notable is a shift from the intelligent consumer to an active modeller (Powell, 1998), to use spreadsheets (Leon et al., 1996) and to teach using case studies (Bodily, 1996).

Initially, this paper describes the design of the questionnaires employed. The results of the educators survey are presented considering their background (demographic and educational) before discussing what they teach (why they teach it, how they teach it and what are the barriers). Finally, the educators were asked how things might be improved. As a comparison, the view of students were sought, with the approach broadly comparable with that for the educators. The company’s perspective has been previously reported (Al-Zawahreh and Cox, 2008).

2 Questionnaires design

The two surveys employed here were designed to evaluate OR education in Jordan. The first was presented to instructors/educators who teach OR courses in Jordanian Universities. These were within business schools and industrial engineering departments. The second was directed to the students taking OR courses in randomly selected Jordanian Universities.

The population for the educators’ questionnaire consisted of all key OR educators in Jordanian Universities (22 universities). While conducting the study, it was found that five universities were technologically and scientifically oriented and therefore did not have a business administration or industrial engineering department. Based on this, the actual population was 17 universities, the number of educators being 51, of which 32 responded.

The population for the students’ questionnaire, included all students enrolled in OR courses in the summer semester of 2003 in the 17 Jordanian Universities, which offered courses in OR. Six universities were randomly selected, 168 students were contacted, of which 90 responded.

Around a quarter (26%) of the students who participated in the survey were from the Hashemite University, 23% from the University of Jordan, 17% from Al-Albayt and 8% from Zarka. These proportions reflect the relative size of the Universities. The University of Jordan has around 35,000 students, Yarmouk University has around 24,000 students and the Hashemite University has about 17,000 students (Census of the Ministry of Higher Education, 2003).

Three methods were used for collecting the educators’ survey, e-mail, mail and a personally administered survey. For the students, a personally administered survey was employed. In these studies, the questions used were a combination of closed and open-ended. The surveys were validated through a pilot study.

3 Results of the educators and the students questionnaires

The first step is to describe the respondents. Of the 17 universities engaged in OR education six were public. The majority of respondents were in the Hashemite University with 13%, followed by Al-Albayt, Yarmouk and Zarka each with 9%. Fewer respondents were in the Arab University for Higher Education, Arab Academic, Al-Isra, Jerash, Petra,
Philippines and Al-Zaytoonah each with 3%. The distribution of the respondents reflects the relative size of the universities.

The majority of educators (87%) were male. This result was expected due to the large number of male academics. According to the census of the Ministry of Higher Education in Jordan in 2003, the total number of academic staff in Jordanian Universities was 5,402, of which only 822 were females. About half of the educators (47%) were younger than 40, while less than one-third of them (31%) were aged over 50.

The majority of OR educators (84%), were Jordanian nationals. Most of the educators who were non-Jordanian were from Arab countries, working particularly in private universities. There is a shortage of experts in this field in both types of Universities in Jordan. Hence, private universities find themselves forced to hire non-Jordanian staff.

According to the census (Ministry of Higher Education, 2003), the total number of academic staff in Jordanian Universities was 5,402, of which 862 were Arabs and 66 were non-Arabs. Therefore, Jordanian staff represents around 83% of the total, which is a similar proportion to those in OR.

This is an area in which experience and exposure to numerous applications is important. Around 43% of the respondents had been in academia for less than 10 years, one-third of the respondents had academic experience of over 15 years. It is clearly a young discipline and would benefit from access to experienced practitioners.

It is important to know the status and background of the academic staff involved. Of the educators 41% were employed as an assistant professors and 19% as a lecturers. Most had a doctoral degree. This reflects the importance of professionally qualified staff to teach OR.

Are the staffs that teach the topic appropriately qualified?

Nearly, 55% of educators graduated from Europe or the USA while 19% graduated from Jordan. Around half the educators (47%) had an academic background in business administration and 22% in engineering. Only 19% of respondents had an academic background in OR/MS. Ideally, the majority of academic staff should be specialists in OR. This result reflects a lack of qualified OR staffs in Jordan, steps need to be taken to broaden the experience of the less formally qualified staff.

We now move on to examine the title of the course delivered.

4 The course title

‘Operations Research’ was the usual name of the OR module given by the majority of educators (88%), the remainder used ‘Quantitative Methods’. It appears that the term ‘MS’ was not used in Jordanian Universities. Kao et al. (1997) carried out a similar survey in Hong Kong, Japan, Korea and Taiwan; they found that the most frequently used name was OR (41%), followed by MS (23%) and Quantitative Methods (14%). Would adopting a universal title for these courses help unify the discipline?

Not surprisingly the students supported this finding with 81(90%) reporting that ‘OR’ was the most common name of the module in their universities. The remaining (10%) stated that the name was ‘Quantitative Methods’; the term ‘MS’ was unpopular in the Jordanian context. It is reassuring that these figures agree with those of the educators.

We now consider how skilled the respondents think they are and where they obtained their training?
The survey revealed that 23(72%) of the educators, claimed a high level of OR knowledge, while only 28% of respondents admitted a moderate level. This result is not surprising, as the respondents were teaching OR courses and this requires a reasonable degree of knowledge. Rotich (1991) carried out a study among 11 educators of OR in Kenya, concluding that 60% of respondents felt they did not have sufficient knowledge of OR, mostly because they did not hold a PhD or other research-based degree. It may be necessary in the future to probe this factor more deeply. Could one design a tool to assess a lecturer’s real knowledge level and would they agree to be tested?

It is also important to assess the student’s background. The majority of the students (91%) had some experience of OR. Of these 47% were at a low level, 38% were moderate and a handful of them (7%) had a high degree of knowledge. It would be interesting to assess these claims against examination performance. This calls for a greater investment in this discipline and the introduction of other courses to increase the degree of knowledge amongst the students.

Further, we explore where individuals obtained their knowledge of OR.

The nature of the questions in this section of the survey allowed the respondents to choose more than one answer for each question; therefore, the total number of responses may differ between questions. The study found that 30(94%) of educators gained their knowledge of OR through taking courses at the university. In addition more than half of them (53%) had obtained their OR knowledge by following other training courses in OR and 47% had practiced OR. This reflects the significant role of university education in acquiring and shaping knowledge in OR. It is necessary to pay more attention to teaching in this important field. The lack of practical experience for half the respondents might be a cause for concern.

Most of the students (91%) predictably gained their knowledge of OR through taking courses at the university. A little lower than the level reported by the educators. While 8(10%) had gained their OR knowledge through self-education and free reading. Only 5% had used and practiced OR and 6% had taken relevant training courses. This indicates that most of the students lacked real life experience in the use of OR. This has a link with the prior question, which indicated that the students have a limited knowledge of OR. Therefore, the opportunity of practicing OR was very slight.

We now investigate if OR education is perceived as important.

All educators indicated that they felt it was very important to teach OR courses in their Universities. This view reinforced the prior result, concerning the degree of OR knowledge. Undoubtedly, this reflects the perceived importance of teaching these techniques but also, maybe, a little self-interest. Some 73(81%) students recognised the importance of following OR courses in their universities.

So OR is important, but why?
8 The usefulness of teaching OR courses

Of the educators 25(78%) believed that the usefulness of teaching OR courses was in the provision of an intellectual challenge to the students, while 69% indicated that OR courses were applicable to real life situations. And 59% reported that OR courses provide students with good job opportunities.

It was found that 10(11%) of the students reported that OR courses were ineffective. While 60% suggested that students look to OR courses to provide them with a good job. Only 20% of the respondents believed that OR courses are applicable to real life situations. This is presumably due to the fact that the students are not fully aware of the suitability and role of OR techniques to real life situations. There is a need to develop relevant real world case studies adapted to the local situation.

9 The objectives of the OR course

The majority of educators (84%) reported that the most important objective of OR courses was to improve students’ general abilities in thinking logically and to develop quantitative skills. Followed by its later use in management practice or advanced studies. Only 8(25%) of the educators indicated that the objective of OR courses was to familiarise students with computers. Higgins (1982) found that although the general purpose of the OR/MS course is to provide students with quantitative skills for decision-making, departments differ in their objectives for this course. The result of the current investigation corresponded to that found in Kao et al. (1997). This is also consistent with the findings of Gunawardane (1991) for AACSB schools (American Assembly of Collegiate School of Business). This perspective should be compared to the impression held by the students.

It was found that 52(58%) of the students believed that the main aim of OR courses was to learn OR for later use in management or advanced studies. While 44% of the students indicated that the aim was to improve students’ general abilities in logical thinking and quantitative skills. 14% reported that the aim was to familiarise students with computers. It is clear that students look on OR courses as an asset for their future professional life. This reflects an inability amongst the students to correctly identify the main aims of the courses as perceived by their instructors.

Where should the ideal course be targeted?

10 To which areas should OR courses pay most attention?

The educators believed that OR courses, taught at Jordanian Universities, should pay special attention to certain areas (linear programming, statistical analysis, forecasting models, simulation and cost-benefit analysis). This might be attributed to the simplicity of these techniques and the availability of standard software packages. Also, these techniques may be more suitable in the Jordanian context. This is similar to the findings of Smith (1987), who found that predictive models such as simulation, forecasting and queuing are more suitable in the Jordanian context. However, integer programming and reliability models were deemed less important. This may reflect the difficulty of these techniques, or their lack of use in the context of developing countries. It is surprising to
find that financial models, decision theory and Markov chains were less popular. These areas are relevant in the Jordanian context and are not highly computer intensive. It might be expected that statistical analysis and some of these additional topics would be delivered in separate courses.

It was found that 66(73%) of the students reported linear programming as the area on which OR courses should concentrate. Around half of the respondents indicated transportation models, a third of the respondent’s decision theory and about a quarter felt that network analysis should be paid more attention. Simulation had less support from the students. Integer and dynamic programming were of little interest. This may reflect the difficulty of these techniques. Deciding what topics to teach is clearly problematic. It is a delicate balance between applicability, complexity and ease of use. Students may be motivated by the desire to obtain a high examination grade.

Having provided the skills, in what areas of management might they be employed?

### 11 Application areas

In ranking business functions that employ OR it was found that production and operations management, project management, marketing management and research and development management were the most popular, while environmental management and knowledge management were the least popular areas. In contrast, Kao et al. (1997) pointed out that the OR/MS course was most useful for production and operations management, followed by information management, finance, marketing and human resources management. Gunawardane (1991) came to a similar conclusion, except that information management was replaced by corporate planning. It is important to stress the ubiquity of these key management skills.

How is the current course delivered?

### 12 Methods for teaching OR techniques

The most popular methods for educators teaching OR are: example calculations (84%), emphasis on theory (75%) and written reports (56%). The least relevant teaching method was oral presentation (22%); case studies and computer practicals were used to a lesser extent in OR courses. This result is similar to that found by Kao et al. (1997). Carraway and Freeland (1989) and Strasser and Ozgur (1995) who maintained that computers were not used for teaching purposes to a great extent in Asian countries. Mingers (1991) carried out a survey of practicing OR groups on UK firms who reported that a live project was considered the most important desirable content of OR courses, followed by report writing, presentation skills and working in groups. This necessitates the paying of more attention to the important methods identified in teaching OR in Jordan.

Some 60(67%) students reported that example calculations were the most common methods used for teaching OR, followed by emphasis on theory (43%), written reports (40%) and oral presentations (13%). Computer practicals and case studies were under utilised in OR courses. It would seem that case studies and practical applications need developing to raise their utilisation in these courses.

What are the contents of the current course?
13 Topics that are covered in OR courses

It is apparent that for 28(88%) of the responding educators linear programming was the most frequently covered topic in OR courses, followed by decision theory (69%) and statistical analysis (63%). Markov chains and simulation were the least popular topics in OR courses. Chen (1981) summarised several surveys on the usefulness of certain OR techniques in the business curriculum, arriving at a different order from the one in this study, finding that simulation were of very little interest. Studies conducted by both Gunawardane (1991) for AACSB Schools and Lane et al. (1993) for ORSA (Operations Research Society of America) members, revealed an interest in simulation. Kao et al. (1997) carried out a survey among business schools in Hong Kong, Japan, Korea and Taiwan. Only the Japanese rated simulation highly. What is surprising is that, although there is a widespread use of computers in Jordanian Universities, the level of usage within OR courses were low. This might be due to the fact that the students are averse to computers and the educators; therefore, make fewer efforts in this discipline. Nevertheless, the situation is expected to change, as simpler and more user-friendly software packages are introduced.

It is hard to explain why decision theory is so prominent when it did not previously feature in the educator’s wish list. While linear programming seems to top every ones list the ranking of the remaining topics is more random. This may be a reflection of the relatively small population of educators.

It is apparent that linear programming was the most popular topic that was covered in OR courses, since 79(88%) students ranked it first. Of the respondents 77% ranked decision theory second and 59% of them ranked transportation and assignment models third. Simulation was the least important topic covered (20%). This might be due to the difficulty of using this technique and the lack of the use of computers in OR courses. Are students necessarily the best judges of what should be in their syllabus?

Having gained the skills, why are they not employed?

14 Reasons for not applying OR subjects in real life

Questions in this section were only posed to the educators. About 16(50%) of them stated that the main reason for not applying OR techniques in real life were that the university courses oriented the students to a theoretical approach. In other words, the courses focused on the theoretical side and neglected the practical one. About 28% of the educators believed that the problem was in the course design. They indicated that the courses were insufficient to provide an adequate knowledge of OR. About 9% had no explanation of why they avoided applying OR principles in real life. It looks like a more practical approach is required. Surely educators have some say in designing their courses?

What makes OR so difficult?
15 Difficulties encountered in OR courses

Of the educators 21(66%) reported that the most common barrier encountered within OR courses were related to the lack of the mathematical background of the students. It was noted that many students accepted in business administration programmes, in particular, had a general secondary certificate in the literature stream (as opposed to the scientific stream) and only a handful of them had a scientific background. This calls for a rethinking and reevaluating of the acceptance programmes in Jordanian Universities. A second barrier was attributed to the lack of practical computer skills among the students. Only 9% of the respondents had experienced no difficulties at all. It appears, then, that most difficulties encountered by the educators were related to the student’s abilities. Are prospective students fully aware of the necessary background required? Rotich (1991) carried out a study in Nigeria, finding that the most common difficulties were related to the lack of experienced personnel among the educators, failure to have a clear understanding of the needs of industry and a lack of computers.

It was apparent that two thirds of the students believed that a shortage of computing facilities was the most common difficulty encountered in OR courses. Half of the respondents ranked teaching methods as a second barrier. This means that the students blamed the university and the educators and considered them responsible for the main barriers that were encountered. While 44% of them ranked a lack of mathematical background as a third obstacle. Around a quarter of them gave a lack of professional experience as the lowest hurdle encountered and only 4% found no difficulties. Most students encountered numerous problems during their OR courses. In a sense these results are predictable. Better preparation of the students and improved computer resources should pay dividends. However, courses should be challenging.

Are the courses broad enough and are they appropriate?

16 Comprehensiveness of the OR courses

Around 61% of the educators believed that OR courses taught at universities were comprehensive enough. Those who indicated that the OR courses were lacking, were asked what strategy should be adopted. Most suggested it was necessary to split and teach in two or three separate courses, to cover as much material as they could. This was because the majority of the Universities teach only a single course in OR. A number of the respondents suggested the importance of the practical side, employing new OR software packages. Some of the respondents suggested that attention should be drawn to introductory courses in statistics and mathematics, giving the students further compulsory courses in these topics before teaching OR. Kao et al. (1997) reported that mathematics for management, statistics, introduction to management, linear algebra and an introduction to computers were the required courses for admission to the departments in business schools, in the Universities in Hong Kong, Japan, Korea and Taiwan. It is not surprising that OR lecturers want to deliver additional courses or that they are loath to develop additional material feeling the course was already sufficient.

How suitable are the OR courses currently taught in the universities to the needs of the decision makers?
17 Suitability of OR courses to decision makers needs

Of the educators 59% reportedly were satisfied with their OR courses. Those who were not asked what improvements and changes they would like to make. Of these 15(79%) indicated that the major change in these courses would be the greater use and integration of computers. They also suggested statistical courses and better computer facilities. Based on the educators’ point of view, the least relevant improvements would be smaller classes and to make these more enjoyable for students. Strasser and Ozqur (1995) found that several authors (Hogg, 1991; Singer and Willett, 1990; Snee, 1993) have also suggested this idea. It has been the subject of heated discussions at several MSMESB (Making Statistics More Effective in Schools of Business) conferences. Do instructors owe it to students to make the class more enjoyable, thereby motivating their interest and maintaining their attention? Or is it their responsibility to present the material and not to entertain? Strasser and Ozqur (1995) revealed that the most popular changes were the greater use of computers, use of real data and to make classes more enjoyable for students.

Should there be more OR courses, better facilities and training?

18 Is another OR course desirable?

The question raised here is related to the capability to deliver another OR course. Of the educators 41% reported that another course is desirable, the rest felt that the current course is sufficient. Those in favour of another course suggested it should focus on the practical side, with extensive use of computers. They also suggested that two related courses were preferable, the first concentrating on the theoretical framework of OR and the second focusing on the empirical aspect and containing more advanced techniques. Some of the respondents suggested a course that gave an opportunity to practice what the students were taught in real life situations. This can be achieved by communication and cooperation between the Universities and companies, particularly in the industrial sector. This again raises the need for relevant case studies. Clearly the usage of computers requires further investigation.

19 Degree of computer usage in OR courses

The study revealed that 14(44%) of the instructors had a moderate level of computer usage in their OR courses while 19% used them extensively and 6% had minimal usage. As a whole, 69% of the respondents used computers in their OR courses. One is concerned about the remaining 31% since even a spreadsheet would count as computer usage. Is manual calculation still being employed?

The study found that 51(57%) of the students never used a computer in their OR course. Of the remainder 22% of them indicated that a computer was used at a moderate level. While 18% maintained that it was used at a minimal level and only 3% used it extensively. This reconfirms the fact that there is a lack of computer usage in OR courses a position that needs addressing.

If computers are available what software is employed?
20  Types of OR software packages used in OR courses

It is found that 18(82%) of the educators, who used computers in OR courses, used standard statistical packages, such as SPSS, SAS and 68% used standard OR packages, such as Lindo, Lingo and the like. These results look quite promising but illustrate the possible confusion on including statistical packages and techniques within these courses.

But why are computers not employed more extensively?

21  Reasons for not using a computer in OR courses

As indicated earlier, 10(31%) respondents did not use computers in their OR courses. They reported that the main reason for not using a computer was its cost (60%) followed by lack of training courses (50%), the university having no interest in computer facilities (40%) and a lack of specialised personnel (20%). Attention now focuses on the views of the students, who in one sense are the customers.

The study revealed that 51(57%) of the students did not use computers in their OR courses. Of these 38 reported that the university lacked computer facilities, this was followed by a shortage of training courses (51%), not being applicable (43%) and a dearth of specialised personnel (35%). The high cost of computers (27%) was the least relevant reason. It seems that the reasons selected were mainly centred on the Universities facilities and instructors experience, as opposed to any fault admitted by the students themselves. Clearly computers need a more thorough integration into these courses.

What about developing additional OR specialists?

22  OR specialists and training

Based on the responses of the educators, it was noted that there was a specialised training department in each university, which delivered programmes on English, computing, leadership and the like. There were some offering programmes in financial analysis and statistical analysis, particularly in SPSS and SAS. However, there were no training programmes, that offered OR. The study revealed that the majority of respondents were not specialists in OR techniques; for example, few educators had a relevant PhD degree; their backgrounds were in engineering and business administration. At the national level, there are organisations and institutions which could offer programmes in OR techniques to enhance the gap in the respondents backgrounds and should be encouraged to do so.

Finally, what do the educators perceive as the future of OR courses.

23  The future of OR courses

Of the educators 81% indicated that the range of OR courses could be extended. They anticipated that the future of OR is bright and expected that the development of OR will progress during the next few years. Moreover, they expected an increase in student
applications for places in OR programmes within business schools and in particular an increase in the use of computers in OR courses. Let us hope, for the readers of this journal, these expectations come to fruition.

24 Conclusions

This is an initial attempt to evaluate the present status of OR education in Jordan. Two types of questionnaires were used in this study. The first was circulated to all educators (51) teaching OR courses in Jordanian universities and the total usable returns were 32, yielding a response rate of 63%. The second was presented to a sample of students (168) studying OR courses. The total usable returns were 90, representing a response rate of 54%. The study concluded that OR education in Jordan is not necessarily relevant to the needs of decision makers. The problems in OR education were related to a lack of local teaching materials, specialised personnel, OR training programmes and computer usage. Further comparative research into the education of OR between the private and public universities would be of interest. Also, a comparative study of the education of OR in Jordan with that in other well-established Arab countries would be valuable. This would reveal if there is any relationship between the political, economic, social and education context and the teaching of OR. It seems that some senior educators are still unaware of the importance of this area.

References


