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Exploring the relationship between undergraduate education and sustainable transport attitudes

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ABSTRACT
The objective of this study is to discuss the impact of education and environmental attitudes on the support for sustainable transport policies among civil engineering students. We surveyed a total of 524 students from Kyoto University, Japan, and asked them about the number of environment-related modules they have taken, their attitudes toward environmental issues, and their attitudes toward various transport policies. We first demonstrate that there is a positive relationship between course selection and environmental concern and discuss self-selection issues by comparing civil engineering students with students from other faculties. We then use a structural equation model (SEM) to show that education and environmental concerns also positively influence attitudes to transportation policies aimed at reducing car usage. We conclude that raising awareness of environmental problems and promoting responsibility through the university curriculum is important to educate future transport decision makers as well as to gain general support for sustainable transportation policies.

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Environmental attitudes; environmental concern; sustainable transport; transport policy; university education

1. Introduction

1.1 *Sustainable transport and university education*

A large number of professionals involved in transport planning graduate from engineering departments. Academics as well as professionals alike have understood that the engineering field, and in particular civil engineering, must undergo major changes. Not only do major universities change the name of civil engineering departments but also professional bodies redefine the tasks of civil engineering. In 2009, for example, the American Society of Civil Engineers (ASCE) published *Vision for Civil Engineering 2025* as a statement that describes a new role for the profession, "a bright, ambitious goal that would guide civil engineers around the globe to a new level of leadership and professionalism" (p. 9). They describe future civil engineers as "master planners, designers, and constructors; lead stewards of the natural environment; master innovators and integrators; managers of risk; and leaders in shaping public policy" (ASCE, 2009, p. 5).

If this is true for civil engineering in general, it is in particular true for students focusing on urban and transport planning. Planners have more influence on the relationship between nature, humans, and the built environment than those being in charge of managing and maintaining infrastructure. In particular, in transport planning the close relationship of changes in the infrastructure, human behavior, and environmental impacts has been studied. This journal as well as a large number of contributions in other transport journals is devoted to the topic of sustainable transport. Impacts of microchanges such as changing speed limits on emissions have been studied, and increasing attempts are made to model short- and long-term impacts of macrochanges such as the road network layout. Further, the inseparable relationship between transport and land use is well known. This means that planning students in particular will need to gain a wider understanding regarding the complexity of our environmental system.

Understanding of the issues alone is not enough, though. Few graduates of planning courses would probably deny that they are aware of the environmental problems caused by traffic. To become lead stewards of the natural environment, students will need to be convinced of the importance of the issues at stake as well as be able to voice their opinion effectively. Ideally education should prepare future decision makers to take a position for the common good in various dilemma situations. Newhouse (1990) writes "Ultimately, people need to be able to make their own moral decisions about environmental matters. The job of educators is to ensure that everyone has all the tools necessary to make responsible environmental decisions" (p. 31). Similarly, Hyde and Karney (2001) conclude that engineering education should not only consider understanding but also whether students care for the environment.

1.2 *Literature on education and environmental attitudes*

This first leads to the question of how far universities can deliver such an education and, more fundamentally, if education can influence environmental problem perceptions and in the long term actually change students' attitudes. This does not appear to have been studied much, specifically for transport planning education. However, there is evidence for the impact

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of university education in more general on students' attitudes, in particular on the impact of economic education. For example, Frank, Gilovich, and Regan (1993) study the difference between students majoring in economics and those from other disciplines. They find not only that economic students are less cooperative but also provide some evidence that the difference to students majoring in other subjects increases with length of education. Also Marwell and James (1981) find differences in the cooperative behavior of economic students, but whether this is due to their education is not clear. Hess-Quimbita and Pavel (1996) report evidence that science education appears to help the development of environmental concern. Using a sample of 18,887 students, they demonstrate that human ethical/social values as well as the number of science modules play important roles in the development of environment concern. Therefore, students' academic and social integration appears to indirectly influence the development of environmentally friendly attitudes. Similarly, Smith-Sebasto (1995) reports changes in students' perceived environmental responsibility through education. He noted that students completing an environmental studies course showed significantly greater environmental responsibility.

In summary, there is some limited literature suggesting that environmental consciousness could, at least to some degree, be taught. This motivated the study that led to this paper. We would like to understand whether course selection and education can play an important role for students to obtain attitudes that encourage them to promote sustainable transport policies in their later working life. To derive some firm conclusions on this, one needs to obtain good panel data that illustrate a change in attitudes for the target group, in this case engineering students that take specific classes, versus other students with the same background that do not take these classes. Because of difficulties in obtaining such panel data, we focus this paper on an exploration of cross-sectional data regarding environmental and transport policy attitudes of those who choose courses with a focus on the environment versus those who choose to study different subjects. As our subsequent analysis will show, we believe this is a first important step to understand what curriculum engineering students that will be involved in transport planning should be taught.

2. Data

2.1 *Environmental education at Kyoto University*

Our analysis is based on a survey among students at Kyoto University. At this university, transport planning education is part of the School of Global Engineering at the undergraduate level, which combines varies civil engineering–related subjects into the curriculum. We survey undergraduate students from different faculties regarding their environmental attitudes in general and their attitudes toward sustainable transport policies in specific. As a proxy for the amount of environmental education received, we consider how many modules with the term *environment* included in the module title the student has taken. Figure 1 shows the number of environmental classes offered among faculties at Kyoto University and departments in the engineering faculty. The Faculty of Agriculture has the most modules related to the environment (31) and the Faculty of Engineering ranks number two with 15 modules that include the term *environment*. Within the Faculty of Engineering, the Department of Global Engineering, which includes transport and urban planning, offers seven environment modules, which is more than other departments (Figure 1). The content of these nonmandatory courses are described in Table 1. In addition to these courses, first-year students have the chance to take a small group seminar over one semester on a topic of their interest. Several of these so-called pocket seminars also focus on environmental issues and we have hence also included these into our count of how many environmental courses a student has taken.

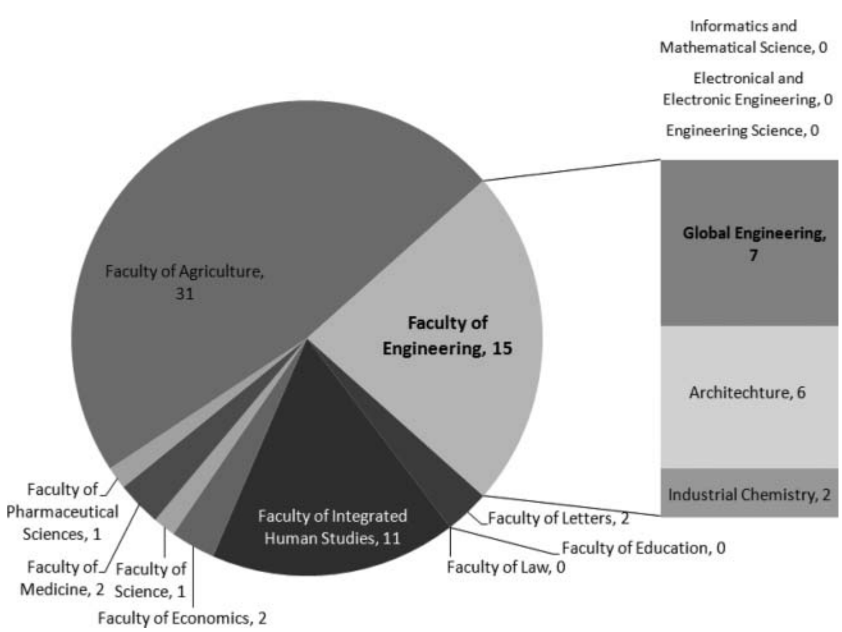

Figure 1. Number of modules with a title including "environment" in Kyoto University (Faculty of Engineering).

Table 1. Modules with a title including "environment" in global engineering (civil engineering).

Name of module (grade in which students take the course)	Contents
Atmospheric and Environment Engineering (3rd)	Global warming, ozone layer depletion, and acid rain problems are introduced. Further air pollution and its health effects are discussed.
Basic Environmental Engineering I (2nd)	This class deals with waste water and sewage management. Moreover, the conservation of the water environment, environmental risk management, and the promotion of a recycling-based society are introduced.
Coastal Environmental Engineering (3rd)	Beach transformation, sediment transport, coastal streams, ocean waves, and irregular waves such as tsunamis are discussed. In addition, the relationships among coastal ecosystems, engineering ethics, and social issues are discussed.
Environmental Equipment Engineering (3rd)	The principles of tools that help purifying the environment are described. Lectures focus on transport material balance, filtration, and sedimentation of particulate matter, waste drying, and absorption of gas.
Environmental Hygiene (2nd)	The lectures introduce the relationship between hygiene and environmental issues including a discussion on public hygiene.
Geotechnical and Environmental Engineering (3rd)	In the environmental engineering part of this lecture series, recycling ground environment; groundwater, soil, and groundwater pollution; and waste disposal are described.
Basic Environmental Engineering II (3rd)	Pollution mechanisms of soil and groundwater are taught as well as case studies of purification technology applications.

As the classes are nonmandatory, the problem of a possible self-selection bias is obvious. We cannot disentangle the effect of interest in environmental issues prior to taking the course from the education effect. We can still observe, though, the change in attitudes toward environmental and transport policy issues due to this (combined) effect among students from different grades. Our focus is therefore on undergraduate students, for two main reasons. First, this is a four-year course over which the impact of education might be more evident than for the two-year master's degree programs. Second, for undergraduate students we assume it is reasonable to presume not much prior knowledge and specific interest in transport policy issues. This is likely to be different for master's students, who will choose specific transport planning–related courses.

2.2 *Respondents*

Table 2 lists the surveys that have been undertaken from March to July 2012. All surveys have been conducted during the last 15 min of lectures. Table 2 presents the corresponding descriptive statistics of the sample. Students from all grades in civil engineering answered our survey, as well first-grade chemical engineering students and third-year students majoring in the economy faculty. A total of 524 observations were gathered for this study. The average age of respondents is 19.9 years and the proportion of males in the sample is 88%, which is fairly representative of the gender split within the engineering school.

We survey also first-year chemical engineering students to understand the effect of prior interest in civil engineering issues on attitudes. We chose chemical engineering partly because we could obtain agreement for surveying in these classes and partly because we believe these students can be a valid control group representing other engineering students with less interest in transport and urban issues. We further survey third-year economics students because they take a subject on transport economy. Therefore, we can assume that they will also have some knowledge about transport planning, though from a different viewpoint, and we hypothesize that there might be differences in environmental interest between these two groups in line with the literature.

The selection of the lectures we surveyed was not influenced by the topic of the module; we rather chose lectures attended by large numbers of students to catch the majority of students in each grade during a single survey. The surveys were administered to students in paper form at the end of classes after previously obtaining the agreement of the respective lecturers in charge of the classes. We explained that this is a survey to understand students' interest in environmental and transport policy issues and that it is purely for research purposes. Students were not provided any incentives and the surveys were collected upon completion, which took on average 10 min.

We ask students about their socio-economical demographics as well as which modules they have taken so far. Students in their first and second years had, on average, taken less than one module directly related to environment issues, which would mostly be the aforementioned pocket seminars. In contrast, students in the third and fourth grades of global engineering took on average 4.4 environmental modules. This is because the majority of the modules are taught in the second semester of the second grade as well as throughout the third grade (see Table 1). We note that we could not survey fourth-year students separately because at Kyoto University there are no

Table 2. Descriptive statistics of data.

	Global (civil) engineering			Chemical engineering	Economy	
	Year 1	Year 2	Years 3 and 4	Year 1	Years 3 and 4	Total
Sample size	138	137	97	101	51	524
Environmental classes taken (mean)	0.52	0.93	4.43	0.04	0.65	1.31
Age (mean)	18.7	19.6	20.9	18.7	21.5	19.9
Gender (% of male)	90.6	93.4	87.6	90.1	78.4	88.0

Table 3. Survey questions regarding environmental concerns.

Self-problem awareness	Do you think the CO_2 that ***you*** produce in your daily life will contribute to climate change and this will negatively influence society?
Personal problem awareness	Do you think global warming will serious damage ***yourself***?
Personal ascribed responsibility	I am not concerned about the environment (–).
Social ascribed responsibility	Every citizen must take responsibility for the environment.

dedicated classes for fourth-year students. Instead, final-year students complete some remaining classes together with third-year students if they have not yet collected sufficient credits and otherwise focus on their final-year project.

3. Education and attitudes

3.1 *Environmental concern*

In the survey we asked questions measuring the environmental concern of students as listed in Table 3. We distinguish problem awareness from ascribed responsibility as well as personal, self, and social dimensions of environmental issues. This set of questions is based on a large set of literature emanating from environmental psychology. Among others, Gärling, Jakobsson, Loukopoulos, and Fujii (2008) report that self-problem awareness is an important factor when discussing acceptance of road user charging in Sweden. Self-problem awareness relates to the awareness that "my own behavior is part of the problem," as discussed, for example, by Choocharukuland and Fujii (2007).

Personal problem awareness describes whether a person perceives the problem to be significantly related not just to the general public but to him or her personally (Gärling et al., 2008). The questions for awareness were taken from Schmöcker, Pettersson, and Fujii (2012) and Kim et al. (2013). Gärling, Fujii, Gärling, and Jakobsson (2003) noted that awareness of consequences must induce an ascribed responsibility to perform the behavior that in turn activates a moral obligation to perform the behavior. In this study, therefore, two questions were taken from Gärling et al. (2003) to measure personal and social aspects of ascribed responsibility. All questions were asked on a 7-point Likert scale. Ratings were obtained with verbally defined endpoints and midpoints ("totally disagree," "neutral," and "fully agree").

3.2 *Comparative analysis*

We hypothesize that environmental education has a significant impact on general environmental problem awareness and ascribed environmental responsibility. We first compare first-year engineering students with those majoring in chemical engineering. Our objective is to understand whether there might be some differences due to environmental interests between the two groups. In other words, differences in environmental attitudes might not be due to education but rather due to attitudinal differences obtained before entering university, which might have influenced their choice of subject.

We compared the values of environmental concern between the two groups as shown in Table 4. We find no significant differences in problem awareness. However, the results show that students who major in civil engineering seem more concerned about the environment as they score higher on personal responsibility. We further compare civil engineering students in upper grades with those majoring in economy. As shown in

Table 4. Comparsion of 1st-year civil and chemical engineering students.

Determinant	Civil engineering 1st students mean (std. dev.)	Chemical engineering 1st students mean (std. dev.)	*t*-test (*p*-values)
Environmental education (average number of taken classes related to environment)	0.51 (1.41)	0.04 (0.20)	
Self-problem awareness	4.75 (1.62)	4.69 (1.77)	0.27 (0.79)
Personal problem awareness	4.88 (1.67)	4.87 (1.70)	0.03 (0.98)
Personal ascribed responsibility	**5.62** (1.32)	**5.05 (1.62)**	**3.01**** **(0.003)**
Social ascribed responsibility	5.31 (1.37)	5.13 (1.36)	1.02 (0.31)

Note. Significance level: **0.05

Table 5. Comparison of 3rd- and 4th-year civil engineering and economy students.

Determinant	Civil engineering 3rd and 4th students mean (std. dev.)	Economy 3rd and 4th students mean (std. dev.)	*t*-test (*p*-values)
Environmental education (average number of taken classes related to environment)	4.43 (1.23)	0.65 (0.56)	
Self-problem awareness	**5.18 (1.50)**	**4.39 (1.47)**	**0.91***** **(0.003)**
Personal problem awareness	**5.03 (1.58)**	**4.49 (1.45)**	**0.87**** **(0.04)**
Personal ascribed responsibility	5.48 (1.56)	5.33 (1.49)	0.57 (0.57)
Social ascribed responsibility	5.32 (1.43)	5.14 (1.40)	0.74 (0.46)

Note. Significance level: **0.05; ***0.01.

Table 6. Comparison of 2nd-year versus 3rd- and 4th-year civil engineering students.

Determinant	Civil engineering 2nd-year students mean (std. dev.)	Civil engineering 3rd- and 4th-year students mean (std. dev.)	*t*-test (*p*-values)
Education (average number of classes taken by the student related to environment)	0.93 (0.43)	4.43 (1.23)	
Self-problem awareness	**4.61 (1.52)**	**5.18 (1.50)**	**−2.85***** **(0.01)**
Personal problem awareness	**4.63 (1.56)**	**5.03 (1.58)**	**−1.94*** **(0.05)**
Personal ascribed responsibility	5.42 (1.53)	5.48 (1.56)	−0.30 (0.77)
Social ascribed responsibility	5.24 (1.48)	5.32 (1.43)	−0.41 (0.68)

Note. Significance level: *0.1; ***0.01.

Table 5, there are large differences in the environmental education received. The results from the comparative analysis indicate that engineering students show higher environmental problem awareness than students with an economy major. This might suggest an education effect but to separate also here the effect of interest from education or age, further data collection will be required.

To separate the effect of prior interest from education and age effects, we compare global engineering students in their second and third grades. These two groups differ significantly in the number of environmental classes taken (0.93 vs 4.43 as shown in Table 6) as discussed before. Assuming that the 1- to 2-year age difference in itself has no impact on environmental problem awareness, we suggest that the results from this comparison can be considered as impact of education. We note though that we cannot distinguish from this table whether the difference is due to the environmental lectures or the general education received. In line with the results in Table 5, self- and personal problem awareness are higher among the more senior students. This suggests that environmental concern can be increased by (environmental) education.

4. Education and transport policy

4.1 *Environmental concern and transport policy*

There is a large body of literature showing that acceptability and acceptance[1] of transportation policy depends on people's environmental concern for climate change or global warming. In particular, Schade and Schlag (2000) demonstrated that the acceptability of road pricing is dependent on people's problem awareness. Similarly, Steg (2003) argues that people who are more aware of the environmental problems caused by car usage are also more likely to perceive needs for policies to solve these and are therefore more likely to accept environmentally friendly policies. Eriksson, Garvill, and Nordlund (2006, 2008) consider personal norms such as moral motivation to reduce environmental problems and the relation to acceptability of travel demand management measures. They discuss that personal norms influence acceptance through willingness to act indirectly and also show that there is a direct correlation among various types of travel demand measures. Moreover, Nilsson and Kuller (2000) verified that environmental attitudes and knowledge are strongly related to the acceptance of various traffic restrictions for private cars such as road toll, petrol tax, and no-parking areas.

4.2 *Attitudes to environmentally friendly policies*

The literature shows evidence that environmental concern influences acceptance of transportation policy. We further showed in the previous section that education appears to influence environmental concern. Therefore, we hypothesize that education is also related to attitudes about environmental and transportation policies, mediated by environmental concern. To demonstrate this, we measured the attitudes towards various policies aimed at restraining car usage.

Table 7. Questions regarding attitudes toward environmental transport policies.

Transport Policy	Question	Mean (std. dev.)
Public transport	Do you feel that all citizens should use public transport in Kyoto?	4.67 (1.63)
Parking charges	Do you support parking charge systems like a pay garage in the CBD or near the train station?	5.14 (1.63)
Eco-inspection	Do you support the law of eco-inspection of cars once in 2 years?	5.15 (1.48)
Expressway pricing	Do you support to pay some fees for using highway?	4.95 (1.45)

In total, four questions are asked as examples for environmentally friendly transport policy (Table 7). The first question is chosen to measure support for the promotion of public transport. In Kyoto, the subway network is limited but there is an extensive bus network that is frequently used by students. For example, the main campus of Kyoto University is accessible by several bus lines but not by subway. The second question aims to understand support for parking restrictions and we ask about attitudes toward parking charges in the Central Business District (CBD) of Kyoto. There are several parking houses and small-capacity parking lots in central Kyoto, which all charge usually around 500 Japanese yen (around 5 US$) per hour. With the third question, we ask students about support of periodic car inspections to reduce CO_2 emissions. In Japan currently there is a regulation that cars older than 10 years must undergo an inspection every 2 years. Finally, expressway pricing is included as a typical Transportation Demand Management (TDM) policy, because all students will be familiar with this as almost all expressways in Japan are tolled.

Since three of these policies can also be promoted for congestion reduction reasons, we include awareness about congestion problems as an additional control variable in our model. To measure congestion problem awareness, following question was asked: "Do you think the congestion level in Kyoto city is serious?" (mean: 5.17, std. dev.: 1.29). In the same way as for the questions for environmental concern, all questions were asked on a 7-point Likert scale. Also, here all ratings were obtained with verbally defined endpoints and midpoints (totally disagree, neutral, fully agree). The transport policy questions were only posed to civil engineering students so that the analysis described subsequently is limited to this group ($N = 372$).

4.3 *Model estimation*

We estimate structural equation models (SEM) to verify the impact of education on transportation policies using the AMOS 21 software. The structural equations are meant to represent casual relationships among the variables in the model. The least-squares method is used for model estimation, which is a general method for the analysis of SEM with latent exogenous and endogenous variables. The equations of our hypothesized model are described as follows and shown in Figure 2, where endogenous variables are

[1] The term *acceptability* should be used for hypothetical or not yet implemented schemes whereas for implemented schemes the term *acceptance* is commonly used (see Gärling et al., 2008; Schuitema, Steg, & Forward, 2010).

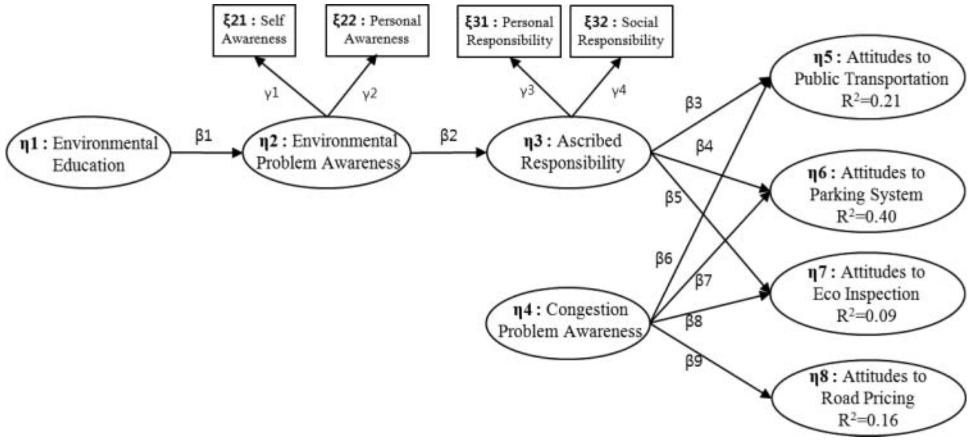

Figure 2. Estimated SEM (civil engineering students only, $N = 372$).

shown as η and exogenous variable as ξ; β and γ are the estimated coefficients of the endogenous and exogenous variables respectively (Fox, 2006). The model estimation results are reported in Table 8, along with t-values.

Environmental problem awareness and ascribed responsibility are both constructed by two indicators each. Self-awareness and personal awareness are grouped as environmental problem awareness with high Cronbach's α of 0.75. Ascribed responsibility includes the two indicators personal and social responsibility. For this construct the reliability is not as high (Cronbach's $\alpha = 0.55$) but we believe it is still acceptable for this model, in which we estimate the weight for γ_3 and γ_4.

Table 8. Results of the estimated model.

Link	Variable	Estimated unstandardized coefficients	SE	t-value	Estimated standardized coefficients
$\beta1$	Environmental education → environmental problem awareness	5.81*	3.14	1.85	1.00
$\beta2$	Environmental problem awareness → ascribed responsibility	0.61**	0.07	8.64	1.00
$\beta3$	Ascribed responsibility → attitudes to public transportation	0.35**	0.13	2.77	0.36
$\beta4$	Ascribed responsibility → attitudes to parking system	0.20*	0.11	1.81	0.16
$\beta5$	Ascribed responsibility → attitudes to eco-inspection	0.21*	0.11	1.86	0.36
$\beta6$	Congestion problem awareness → attitudes to public transportation	2.04**	0.71	2.85	0.93
$\beta7$	Congestion problem awareness → attitudes to parking system	2.74**	0.96	2.85	0.99
$\beta8$	Congestion problem awareness → attitudes to eco-inspection	1.25**	0.49	2.54	0.93
$\beta9$	Congestion problem awareness → attitudes to road pricing	1.69**	0.60	2.80	1.00
	Environmental problem awareness (Cronbach's $\alpha = 0.75$)				
$\gamma1$	(Self-problem awareness)	1.000	—	—	0.77
$\gamma2$	(Personal problem awareness)	0.97**	0.09	11.19	0.76
	Ascribed responsibility (Cronbach's $\alpha = 0.55$)				
$\gamma3$	(Personal responsibility)	1.000	—	—	0.52
$\gamma4$	(Social responsibility)	1.08**	0.14	7.65	0.58

*$p < 0.10$; **$p < 0.05$.

On the right are the attitudes to the four transport policies. We only allow for paths from left to right. We hypothesize that environmental education is a more distal factor than environmental problem awareness and estimate a model embedding the hypothesis of a direct path from environmental problem awareness to ascribed responsibility as done by Gärling et al. (2003). Environmental problem awareness in turn was hypothesized to influence both ascribed responsibility and congestion problem awareness, which are considered as direct determinants of the policy attitudes.

The estimated model confirms that, as hypothesized, environmental education is indirectly associated with attitudes to transport policies through environmental problem awareness and ascribed responsibility. We do not find a significant path from environmental problem awareness to congestion problem awareness so that the latter appears to be a separate variable influencing attitudes toward transport policies. The final model only includes paths that are found significant at least at the 10% level. The overall goodness of fit (GFI) of the model appears to be acceptable with GFI[2]= 0.97, adjusted GFI = 0.95, RMSEA[3]= 0.05, and CFI[4] = 0.94.

Considering the path coefficients in Table 8 and total effects in Table 9, the following observations appear important to us: First, we find a significant path between education (number of environmental classes attended) and environmental problem awareness. This is equivalent to our results in Sec. 3 and suggests that (environmental) education influences environmental problem awareness. Moreover, Figure 2 shows that awareness has a significant effect on ascribed responsibility and responsibility positively influences attitudes to the transportation policies except for expressway pricing. Finally, we find that

[2] GFI (goodness-of-fit index): GFI varies from 0 to 1, but theoretically can yield meaningless negative values. By convention, GFI should be approximately 0.90 or more to accept the model. By this criterion, the present model is accepted.

[3] RMSEA (root mean square error of approximation): There is adequate fit model if RMSEA is less than or equal to 0.08.

[4] CFI (comparative fit index): In examining baseline comparisons, the CFI depends in large part on the average size of the correlations in the data. If the average correlation between variables is not high, then the CFI will not be very high. A CFI value of 0.90 or higher is desirable (Kline, 1998).

Table 9. Total effects on transport policies.

Attitudes to transport policy	Congestion problem awareness (direct effect)	Education (indirect effect)	Environmental problem awareness (indirect effect)	Ascribed responsibility (direct effect)
Attitudes to public transportation	2.04**	1.25**	0.22**	0.35**
Attitudes to parking system	2.74**	0.72*	0.12*	0.20*
Attitudes to eco-inspection	1.25**	0.76**	0.13**	0.21**
Attitudes to road pricing	1.69**	—	—	—

*$p < 0.10$; **$p < 0.05$.

congestion problem awareness influences all four policy types. We only hypothesized this link for three of the policies but also found a significant path to eco-inspection.

When we compare the effects of ascribed environmental responsibility on policy attitudes, the explanatory power for public transportation support is higher than for the support of eco-inspection and parking charges. Furthermore, the $\boldsymbol{\beta}$ coefficients for the latter two policies are only significant at the 10% level. A significant effect of ascribed responsibility on expressway pricing could not be established. Congestion problem awareness has a strong correlation with the support of parking restrictions. Support for public transport focused policies and road pricing policies are also significantly correlated with congestion problem awareness, but there is a relatively weak correlation with environmental transport policies.

The results are further illustrated by the description of the total effects in Table 9. Education, via problem awareness and ascribed responsibility, primarily increases the support for public transport; the effects on support for eco-inspection and parking policy are weaker. These three policies are positively determined by ascribed responsibility as well as congestion problem awareness whereas acceptance of road pricing is influenced by only congestion problem awareness. Both predictors explain 21% of the variance in support for the public transport policy, 40% of parking policy acceptance variance, but only 9% of eco-inspection acceptance variance. The low value for eco-inspection might be due to many students not having a strong opinion on this issue. As mentioned before, only older cars require currently an inspection and most of the students are not car owners. In how far the results described in this section are influenced further by Kyoto- and Japan-specific experiences of the respondents should be explored though in further research.

5. Conclusion

Sustainable transport is not achievable without planners who fully embrace such policies. Planners are created at universities through appropriate education. Many major universities are nowadays rethinking therefore their engineering curriculum to (a) address a more global audience and (b) respond to changing needs toward more sustainable transport policies. Environmental education is in many institutions seen to be of primary importance though evidence on the impact of education has been largely missing so far. The aim of this study is to be a first step to close this knowledge gap.

With a survey among Kyoto University undergraduate students, we show that already first-year civil engineering students perceive higher responsibility for environmental problems than students from chemical engineering, which we take here as a control group for students with other majors. This suggests that the connectedness of infrastructure and environment is understood fairly early.

We further showed that senior civil engineering students appear to have higher environmental problem awareness than students majoring in economy. Whether this is due to education or prior interest in environmental issues, we cannot distinguish. Independent of distinguishing the cause for the difference, our findings suggest that graduates with an economic major might have a different outlook on transport problems than graduates from engineering faculties. This is in line with Yezer, Goldfarb, and Poppen (1996), who compared cooperation in dilemma situations between economic students and those belonging to other faculties. They found that economic students cooperate less and that exposure to economic classes is correlated with lowered cooperation. Erikson (2008) also shows that cooperation in dilemma situations and pro-environmental behavior are related.

We also verified that, among civil engineering students, education increases environmental problem awareness. Problem awareness includes self and personal aspects, i.e., understanding of the environmental effects of one's own actions as well as the effects of environmental problems on one's own future. Such problem awareness will help transport decision makers to understand the importance of sustainable transport policy. We could not verify any direct education effects on ascribed responsibility. In particular, gaining social ascribed responsibility will help transport planners to understand the role of community involvement for achieving sustainable transport. There appears to be though an indirect effect of education on ascribed responsibility via problem awareness.

Our fourth major finding is that education also influences attitudes to transportation policies, again highlighting the role of university education in shaping our future transport policies. We demonstrate with an SEM analysis that congestion awareness and ascribed responsibility influence attitudes toward various transportation policies among engineering students. It is shown that support for transport policies that promote public transport and car use restrictions are significantly correlated with environmental concern. This means that students who have been better educated about environmental issues are more likely to support the usage of public transport or the need of other environmental policies. More generally, one might also conclude that increasing public awareness of, and responsibility for, environmental issues is important to gain wider support for specific transportation policies.

We believe therefore that our study highlights the role of education for attitudes to transport policy. We show the effect of environmental education but cannot clearly distinguish it from the general education effect. Therefore, it is beyond this study to give some specific suggestions on detailed subjects that should be included in a curriculum. We can conclude, though, the importance of raising the perception of responsibility and problem awareness through education. Connected to this and our findings by comparing students from different faculties, we suggest that our study implies that employers of graduates are well advised to consider not only knowledge and skills but rather wider education and general environmental interests when recruiting.

Our study clearly has some limitations, as already discussed in various parts of this paper. We conclude this paper by highlighting three main issues that we hope can be addressed in further work with additional data. First, our proxy for the amount of environmental education is the number of modules students have taken with the name *environment* in the module title. Obviously, also other modules might teach environmental aspects and we cannot distinguish further the content or quality of education with our survey. Second, as mentioned, in our comparison with students from other faculties, we cannot control whether students entering the Faculty of Engineering chose this faculty because of previous environmental interests. Third, we did not consider knowledge of environmental issues and transport policy directly. Instead we suppose that problem awareness is activated by knowledge about environmental issues (cf. Schwartz, 1977). We therefore included environmental problem awareness as an indirect index for knowledge. In subsequent work one might ask some direct questions on knowledge of specific environmental and transport policy–related questions. Schade and Schlag (2003) indicate that knowledge is an important variable for acceptance of pricing policies, and moreover education should improve knowledge, which in turn may change attitudes.

Therefore, in future studies we hope to repeat this survey and collect panel data in order to directly measure the change in environmental attitudes over the 4 years. We further hope that with more detailed data the effect of some specific modules on environmental attitudes can be analyzed. Finally, it is our hope that similar studies might also be conducted at other universities in order to confirm our findings and derive more detailed practical conclusions on how to best educate future transport planners.

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