Knowledge and Technology Exchange (KTE) Survey at Eawag

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Executive Summary

Knowledge and Technology Exchange (KTE) is, in addition to research and teaching, one of the three key tasks of Eawag's researchers. Due to the relevance of KTE for Eawag's mission, a survey was conducted in order to learn about the experiences, needs, and motivation of Eawag's researchers. KTE is defined as 'a two-way exchange of knowledge and/or technology between scientists and stakeholders outside the scientific community. Such external stakeholders include actors from private enterprises, government, professional and/or civil society, and the general public. KTE encompasses all facets of knowledge production, sharing, storage, mobilisation, translation and use (Cvitanovic, McDonald, and Hobday (2016), adapted for this survey).'

The goal of the survey was to provide information that could aid in designing effective measures to support Eawag's researchers in their future KTE activities. The findings reported here must be considered as preliminary because of the survey response. Although 232 researchers were given access to the survey, only 13% (29 researchers) completed the entire survey. Nearly all (93%) of these researchers had prior experience with KTE. Therefore, the survey results cannot reveal the concerns or preferences of Eawag researchers without KTE experience. An additional 11 researchers began the survey but answered only the first question regarding prior KTE experience. Most (73%) of these researchers reported no recent KTE activities.

Although these survey results can only be considered as preliminary, it is useful to note that the reported importance, motivations, and needs for KTE activities were not different for subgroups of researchers with differing 'mode of employment' and 'prior experience outside of academia'. Therefore, the recommendations in the following paragraphs can be provisionally applied without making such distinctions.

The results on the **importance of specific KTE activities** for the participating researchers show that KTE activities done in cooperation with external stakeholders are of equal importance as KTE activities tailored to external stakeholders. Another result is that a variety of the KTE activities specified in the survey are important for and applied in their research. In addition, several scientists mentioned further activities in the text box. Therefore, a recommendation for Eawag is to offer support for a wide range of KTE activities instead of a small selection. Besides that, the participation of researchers in a certain KTE activity often matches with its stated importance. This observation suggests that researchers pursue opportunities to engage in KTE activities that are of high importance for their research. This positive finding shows that the conditions at Eawag allow meaningful KTE activities to be conducted. It would also seem advisable that support for specific KTE activities should focus on activities with the greatest mismatch between 'importance' and 'actual engagement'. These are 'tailoring information to the needs / context of external stakeholders' (Q_9 and Q_20) and 'organising events (trainings, workshops, conferences ...) for external stakeholders' (Q_7 and Q_18).

Beyond, the study shows that the scientists currently conduct KTE activities mainly based on intrinsic **motivation**. In contrast, fewer scientists agree with statements corresponding to extrinsic motivation. Thus, Eawag could consider two approaches to support the motivation of researchers for KTE activities. One option is to cultivate the intrinsic motivation of the scientists. Some ideas on how this could be done were summarised briefly by Barreiro and Treglown (2020). The other option is to expand the range of extrinsic motivators. Ideas for specific external motivators are presented in the following paragraphs.

The results on measures that are rated as helpful to **increase the effectiveness of KTE activities** can be separated into different sub-areas. They are institutional support by Eawag, interaction with

external stakeholders, individual skills of the researcher, and alteration of the scientific system. One result is that the institutional support by Eawag is not preferred over the other sub-areas. In addition, the level of agreement with statements (i.e., on the Likert scale) varies. Based on this observation, some suggestions can be made for the prioritisation of additional support for specific activities.

In terms of institutional support, a majority of the participating scientists pointed out that dedicated funding (Q_30) would increase the effectivity of their KTE activities. Comments referring to this aspect advance concrete examples, e.g. funding for KTE related subtasks within a project. Other comments mention existing programmes in Switzerland (Innosuisse) and abroad ('Stream – Shaping careers, delivering innovation'). Both suggestions can be found in literature as well (e.g. Cvitanovic et al. (2015); Young and Freytag (2020)). Therefore, a review of Swiss programmes and experiences in other countries could give valuable insights into concrete possibilities for Eawag's researchers.

Concerning an increased effectiveness of interaction with external stakeholders, a majority of survey respondents indicated that that they would welcome opportunities to integrate external stakeholders in projects from onset to completion (Q_24). The benefits of projects that are jointly developed by all stakeholders are confirmed by several authors (Cvitanovic et al. 2015; Young and Freytag 2020; Beier et al. 2017; Wyborn et al. 2019). In this regard, further information about existing measures or possibilities to initiate new measures for integration could be useful.

Referring to the personal abilities of the researchers, it stands out that half of them indicate that it would be valuable for their work to be better trained in science communication (Q_22). It can be assumed that this skill supports the recommendation regarding editing of information to the needs / context of external stakeholders (Q_9 and Q_20) which was mentioned above under important activities. Many scholars (e.g. Bammer (2020); Scalice et al. (2019)) report on the benefits of science communication. Their findings could serve as starting point for further investigations on how this knowledge could be made available for Eawag's researchers.

Furthermore, a majority of scientists would like the scientific system to be altered in order to include measures for KTE activities. Schmoch and Schubert (2009) point out that all areas of responsibility of scientists should be included in the measures of scientific performance. If incentives are set for only a few areas of responsibility, it prevents the achievement of the best overall results. This is because researchers tend to base their decisions for time investments on incentives instead of their individual talents and interests (Schmoch and Schubert 2009). Since an individual institution like Eawag cannot change a globally applied approach, Maag (2018) suggests coalition building with institutions that have a similar mind-set and lobbying for a change. Several groups of researchers have already made suggestions for the evaluation of KTE activities. The objects of evaluation range from institutions (Ishizaka et al. 2020; Schmoch and Schubert 2009; Holi, Wickramasinghe, and Van Leeuven 2008) to projects (Krause and Schupp 2019; Treffeisen, Grosfeld, and Kuhlmann 2017), and individual scientists (Maag et al. 2018). An in-depth literature review could be helpful in order to develop a useful evaluation method to meet Eawag's needs.

Finally, it needs to be re-emphasized that the findings of this survey reflect a low response rate and must be considered as provisional. Although the findings can help to identify issues of relevance for the KTE activities of Eawag's researchers, the perspective of researchers who are not engaged in KTE is missing. This precludes the identification of barriers to KTE engagement, which warrant further investigation.

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1 Introduction

The responsibilities of scientists working at Eawag include research, education, and the transfer of research findings to external stakeholders. In this document, the latter is referred to as 'knowledge and technology exchange' (KTE). KTE is defined as follows:

> 'Knowledge and technology exchange is a two-way exchange of knowledge and/or technology between scientists and stakeholders outside the scientific community. Such external stakeholders include actors from private enterprises, government, professional and/or civil society, and the general public. KTE encompasses all facets of knowledge production, sharing, storage, mobilisation, translation and use.

The definition is taken from a publication by Cvitanovic, McDonald, and Hobday (2016) who based it on the works of Mitton et al. (2007) and Best and Holmes (2010). It was slightly adapted for this study. While the definition emphasises the bilateral knowledge exchange of scientists and external stakeholders, this study focusses exclusively on the viewpoint of the scientists. Its aim is to learn more about the experiences, needs and motivators regarding KTE activities of different groups of researchers at Eawag. An online survey is conducted in order to obtain results that are a one-to-one reflections of the situation at Eawag. It is expected that the findings aid the decision making for effective measures to support future KTE activities of Eawag's researchers.

2 Methodology

The analysis of the quantitative items is based on several tools due to the different levels of measurement used. Questions with a nominal level of measurement (applies to Q_1 (page 2), Q_10 – Q_20 (page 4), Q_21 (page 5), and Q_42 – Q_44 (page 9)) were analysed using descriptive statistics. Questions with an ordinal level of measurement (applies to Q_2 – Q_9 (page 3), Q_22 – Q_27 (page 6), Q_28 – Q_33 (page 7), and Q_34 – Q_41 (page 8)) use the 5-point Likert scale. They were analysed using descriptive and inferential statistics. Regarding the data from Likert scales it need to be mentioned that there is an ongoing discussion among statisticians (see e.g. Calver and Fletcher (2020), de Winter and Dodou (2010); Ghosh et al. (2018), Grech and Calleja (2018), and Harpe (2015)) whether it is acceptable to treat the data as interval data. Opponents of this approach argue that the distance between the points of the Likert scale cannot be proven to be equidistant (e.g. the distance between 'strongly agree' and 'agree' is not necessarily the same as the distance between 'agree' and 'undecided') (Calver and Fletcher 2020). Advocates however justify their approach by mentioning that Rensis Likert had meant the points to be equidistant (see (Harpe 2015) referring to (Likert 1932)). An option to circumvent confusion for the participants of surveys and allowing an analysis based on arithmetic operations is by serially numbering the five points of the Likert scale (Harpe 2015). In the case of this survey, the five Likert points were numbered from 4 to 0 with the 4 being associated with 'very important' and 'strongly agree' respectively. Nevertheless, serial

numbers do not bring clarity to what expressions like for example 'undecided-and-one-third' mean (Harpe 2015).

The discussion whether Likert scale data is ordinal or interval is of relevance when deciding for the type of tests that can be applied. Defining the level of measurement to be interval can allow for the application of parametric tests (like the t-test). In addition to the level of measurement, further conditions have to be met. These are a sample size of $n \geq 30$ and normally distributed data. If only one of the two latter criteria is not met (sample size is $n < 30$ and / or data points are not normally distributed), it is recommended to use non-parametric tests (Harpe 2015). In the case of this survey, the sample size is small ($n < 30$; see chapter 3.1 for details). Therefore, it is advisable to use non-parametric tests which are applicable to both ordinal and interval data. Thereby, in this case a decision is not relevant on whether the Likert scale data can be treated as interval data or not. An advantage of non-parametric tests is that they are robust and that their results point into the same direction as those of parametric tests (Ramachandran and Tsokos 2021).

Table 1 Distribution of the survey participants into subgroups based on their answers (combinations that are not displayed in this table were not found among the participants)

	subgroup A (A.1 and A.2)			**subgroup B**			**subgroup X**	
mode of employ-ment (Q_42)	permanent contract			fixed-term contract			?	
leading position (Q_43)	yes	yes	yes	yes	no	no	?	
prior experience outside of academia (Q_41)	yes	no	no	no	yes	no	?	
KTE activities in the past two years (Q_1)	yes	yes	no	yes	yes	no	yes	no
number of participants	**10 (A.1)**	**9 (A.2)**	**1**	**1**	**7**	**1**	**3**	**8**
size of subgroup	**20**			**9**			**11**	

For the analysis of this survey, the data of the respondents were divided into different subgroups based on their answers to question Q_1 (page 2) and Q_41 – Q_43 (page 9). All four questions are mandatory. They address the two fields 'employment' (Q_42 and Q_43) and 'experience' (Q_1 and Q_41). Participants who finished the questionnaire after answering the first question (Q_1) form subgroup X (see Table 1). The remaining participants (29) are split into two subgroups A (scientists with a permanent contract) and B (scientists with a fixed-term contract) (see Table 1). Additionally, some of the responses in subgroup A were grouped again into two subgroups A.1 and A.2. Subgroup A.1 is representing scientists with a permanent contract who have experiences in KTE prior to their engagement at Eawag and in the past two years. In contrast, subgroup A.2 represents scientists with permanent contracts who have no experience in KTE prior to their engagement at Eawag but have been involved in KTE activities in the past two years. The Mann Whitney U test (also called Wilcoxon rank sum test) was used in order to decide whether the independent samples forming the subgroups (subgroup A versus B and A.1 versus A.2) are representing the same or different populations. The Mann Whitney U test is a nonparametric test (see above) that can be used for ordinal data and small sample sizes (Beatty 2018). It was applied on the results of the four Likert scales of this survey (page 3: Q_2 – Q_9; page 6: Q_22 – Q_27; page 7: Q_28 – Q_33; and page 8: Q_34 – Q_41). The results are described in subchapter 3.3.

Table 2 Colour code for the column 'Median (MED)' in Table 6, Table 11, Table 12, and Table 13

column 'Median (MED)'	
statements Q_2 - Q_9	**statements Q_22 - Q_41**
'very important'	'strongly agree'
'very important' - 'important'	'strongly agree' - 'agree'
'important'	'agree'
'important' - 'moderately important'	'agree' - 'undecided'
'moderately important'	'undecided'
'moderately important' - 'slightly important'	'undecided' - 'disagree'
'slightly important'	'disagree'
'slightly important' - 'unimportant'	'disagree' - 'strongly disagree'
'unimportant'	'disagree'

Table 3 Colour code for the column 'Normalised Total Score (NTS)' in Table 6, Table 11, Table 12, and Table 13

column 'Normalised Total Score (NTS)'
100 - 81
80 - 71
70 - 61
60 - 51
50 - 41
40 - 31
30 - 0

In addition, to the Mann Whitney U test the following four calculations were applied to the data. Firstly the median (MED; see Table 2 for colour code) and the normalised total score (NTS; see Table 3 for colour code) were calculated for each item. The MED is used to give a first indication about the general importance and agreement respectively. Moreover, the NTS helps to rank the items within a scale and to compare items of different scales with each other.

Table 4 Colour code for the column 'Top 2-Box (T2B)' and 'Bottom 2-Box (B2B)' in Table 6, Table 11, Table 12, and Table 13

column 'Top 2-Box (T2B)'	column 'Bottom 2-Box (B2B)'
100% - 80%	0% - 20%
79% - 50%	21% - 50%
49% - 0%	51% - 100%

Secondly, the sum of the percentage of votes in the boxes with highest importance and agreement respectively (top 2-box, T2B; see Table 4 for the colour code) and sum of the percentage of votes in the boxes with lowest importance and disagreement respectively (bottom 2-box value, B2B; see Table 4 for the colour code) are presented. These values give an indication on the distribution of votes. The four mentioned calculations were chosen because, like non-parametric tests, they can be applied to both ordinal and interval data. Calculations like the arithmetic mean or the standard deviation were not performed because they should not be applied to ordinal data.

3 Results of the Questionnaire

This chapter presents the results of the survey. Firstly, subchapter 3.1 gives an overview over the overall participation. Secondly, subchapter 3.2 contrasts the results of subgroup X (only Q_1) with subgroup A + B. Thirdly, subchapter 3.3 presents the findings of the Mann Whitney U test applied to the results of subgroups A (permanent contract) versus B (fixed-term contract) and subgroups A.1 (permanent contract, prior experience in KTE) versus A.2 (permanent contract, no prior experience in KTE). The remaining subchapters 3.4 to 3.7 focus on the results of questions Q_2 to Q_40 and present detailed findings related to KTE. Furthermore, they incorporate any topic related comments that were made by the participants on page 10 of the survey.

3.1 Participation

Within a period of nine days, 39 scientists of the 232 invited scientists answered at least one question of the questionnaire. An additional set of answers was included in the analysis disregarding its late submission (on Monday, 23.11.2020). This results in a survey participation rate of 18% (Figure 1). The majority of the forty participants (29 persons; 13% of the total (= survey completion rate), subgroup A + B) answered most questions. The remaining participants (11 persons, 5% of the total, subgroup X) answered the first question (Q_1) only (see Figure 1).

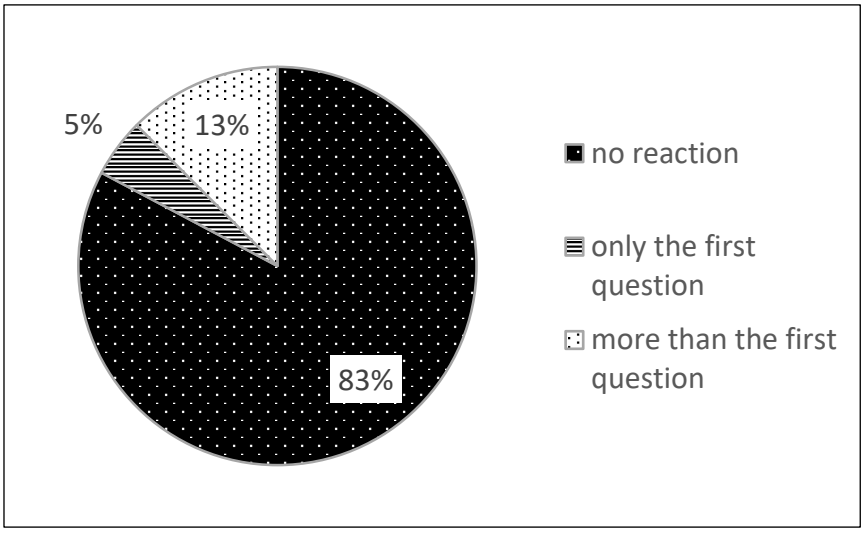

Figure 1 Pie chart representing the reactions on the survey of the complete group of the recipients: 83% of the recipients of the survey did not react on it, 5% of the participants of the survey answered the first question only, and 13% of the participants of the survey filled out most questions.

3.2 KTE definition (page 2, Q_1)

Page 2 of the questionnaire presents the definition of KTE applied in the survey and the first question (Q_1): “In the last two years, have you been involved in any KTE activities that match the above definition?”

The analysis of results for all 40 participants (subgroups A, B, and X) reveals that 75% of the participants (30 persons) were involved in KTE activities in the past two years. It is noticeable that this share changes drastically when splitting the participants into the subgroups A + B (continued the questionnaire after Q_1) and X (answered only Q_1). Survey takers in subgroup A + B answered “yes” in 93% of the cases (27 persons). This is in contrast to a share of only 27% of affirmative answers in subgroup X (3 persons). A comparison of the results of question Q_1 for the subgroups A and B reveals that the numbers do not differ much from the numbers presented in the pie chart in the middle in Figure 2. There is one person in each subgroup A and B respectively who has not been

involved in KTE activities in the past two years. This gives a result in percentage of 95% and 89% affirmative answers for question Q_1 in subgroups A and B respectively.

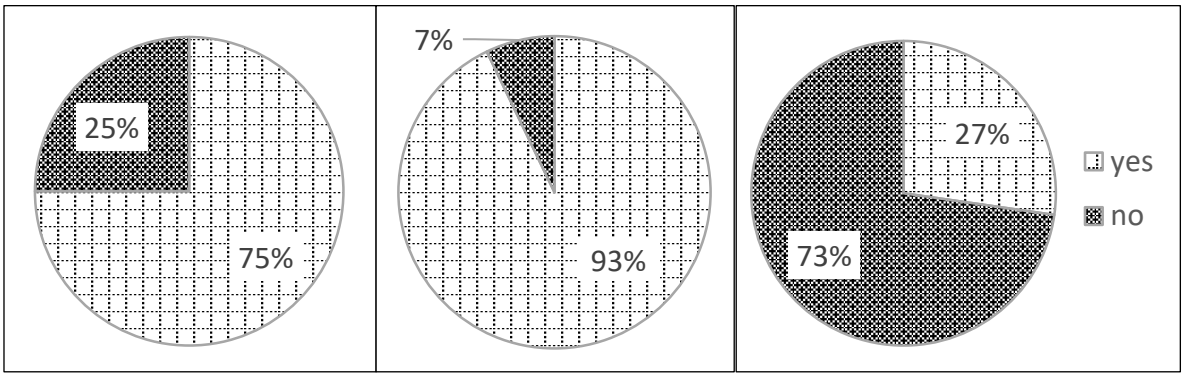

Figure 2 Pie charts displaying the distribution of the answers "yes" and "no" for the question Q_1: Left: distribution for 40 participants (all); Middle: distribution for 29 participants (subgroup A + B: continued the questionnaire after question Q_1); Right: distribution for 11 participants (subgroup X: answered only question Q_1).

3.3 Mann Whitney U test

The results of the Mann Whitney U tests applied to the findings of subgroup A versus B for the four Likert scales of the survey (page 3: Q_2 – Q_9; page 6: Q_22 – Q_27; page 7: Q_28 – Q_33; and page 8: Q_34 – Q_41) are all the same. In none of the four tests could the null hypothesis be rejected (Table 5). Similarly, the tests for subgroup A.1 versus A.2 found that the null hypothesis could not be rejected (Table 5). Thus, the result is that the scientists forming the different subgroups (subgroup A versus B and A.1 versus A.2) are all part of the same population. Therefore, subchapters 3.4, 3.6, and 3.7 neglect any division into subgroups. All presented results are based on an analysis of all participants of the questionnaire (subgroup A + B).

Table 5 Results of the Mann Whitney U test for all Likert scales of the questionnaire

subgroups	**Likert scale**	**Null hypothesis: "The scientists of both subgroups …**	**Results for all items of the scale concerning the null hypothesis**
A versus B	Q_2 – Q_9, page 3	… rate the importance of this statement equally"	cannot be rejected
	Q_22 – Q_27, page 6	… show the same level agreement for this statement"	cannot be rejected
	Q_28 – Q_33, page 7		cannot be rejected
	Q_34 – Q_41, page 8		cannot be rejected
A.1 versus A.2	Q_2 – Q_9, page 3	… rate the importance of this statement equally"	cannot be rejected
	Q_22 – Q_27, page 6	… show the same level agreement for this statement"	cannot be rejected
	Q_28 – Q_33, page 7		cannot be rejected
	Q_34 – Q_41, page 8		cannot be rejected

3.4 Importance and frequency of KTE activities

3.4.1 Important KTE activities for own research (page 3, Q_2-Q_9)

The third page of the questionnaire asks the survey taker to rate the importance of eight KTE activities for their own research: “How important are the following knowledge and technology exchange (KTE) activities for your research?”

The eight statements Q_2 – Q_9 are grouped into two sub-sections. They can be distinguished by the role of the external stakeholders. The first sub-section (Q_2 – Q_6) lists activities that are done in cooperation with external stakeholders (Table 6) while the second sub-section (Q_7 – Q_9) lists activities that are tailored to external stakeholders (Table 7). A comparison of the normalised sums of the NTS shows that both sub-sections were rated with a similar importance (activities in cooperation with external stakeholders = 69 (Q_2 – Q_6); activities tailored to external stakeholders = 72 (Q_7 – Q_9)).

Table 6 Overview of the statements Q_2 - Q_6 (page 3 of the questionnaire) on the importance of activities done in cooperation with external stakeholders in the order of the highest to lowest importance as rated by the participants of the survey.

No.	statement	Median (MED)	Top 2-Box (T2B)	Bottom 2-Box (B2B)	Normalised Total Score (NTS)
Q_2	being part of collaborative projects with external stakeholders	very important	86%	7%	84
Q_4	maintaining informal contacts with external stakeholders	very important	85%	7%	81
Q_6	supporting the implementation of results	important	61%	14%	71
Q_5	creating opportunities (trainings, workshops, conferences, joint teaching, joint supervision of students ...) for exchange / learning with external stakeholders	important	57%	21%	64
Q_3	jointly using technical infrastructure with external stakeholders	important - moderately important	50%	39%	47
					69

Generally, it can be said for both sub-sections that the participants of the survey rate the majority of the statements as ‘important’ or even ‘very important’ (based on the MED for Q_2 – Q_9). A close look to the calculated numbers shows that it is very important (MED ‘very important’, T2B above 80%, and an NTS higher than 80) for the participating scientists to collaborate with external stakeholders in projects (Q_2) as well as maintaining informal contacts (Q_4). Furthermore, tailoring information to the needs of external stakeholders (Q_9) is inconsiderably less important (MED ‘important’, T2B above 80%, and an NTS of 78). Of slightly smaller relevance (MED ‘important’, T2B ranging from 67% - 57%, and an NTS between 71 and 64) is the importance of doing expert consulting (Q_8), supporting the implementation of results (Q_6), and the organisation of events for (Q_7) or with (Q_5) external stakeholders. The joint use of technical infrastructure (Q_3) is of lowest importance of these eight statements for the participants of the survey. The median is between ‘important’ and ‘moderately important’. The highest two boxes (T2B) of the Likert item (‘very

important' or 'important') were chosen by exactly 50% of the participants while the box 'unimportant' was also chosen by 36% of the participants (NTS 47).

Several participants of the questionnaire noted down further KTE activities that are important for their own research. One of these activities is the participation in the creation of (technical) guidelines. Another activity is the participation in external events. Likewise, the collaboration with working groups by providing scientific support and engaging in practice-oriented organisations (like SVGW, VSA, and Pusch) were mentioned. Moreover, one survey taker listed the promotion of a change of emphasis toward "new scientific knowledge (e.g. climate change adaptation)" as important.

Table 7 Overview of the statements Q_7 - Q_9 (page 3 of the questionnaire) on the importance of activities tailored to the needs of external stakeholders in the order of the highest to lowest importance as rated by the participants of the survey.

No.	statement	Median (MED)	Top 2-Box (T2B)	Bottom 2-Box (B2B)	Normalised Total Score (NTS)
Q_9	tailoring information to the needs / context of external stakeholders	important	81%	7%	78
Q_8	doing expert consulting for external stakeholders (reports / expertise)	important	67%	15%	70
Q_7	organising events (trainings, workshops, conferences ...) for external stakeholders	important	59%	26%	69
					72

3.4.2 KTE activities the scientists engaged in (page 4, Q_10 – Q_20)

Page 4 of the questionnaire asked the scientists to indicate in which of the eleven listed KTE activities they have been or are engaged in ("In which of the following knowledge and technology exchange (KTE) activities did you engage in during the past two years? (This can include on-going activities.)"). The participants were able to tick all statements that apply to them. Furthermore, a text box offered the survey taker to mention additional activities or leave a comment.

More than 75% of the participants (21 persons or more of 27, Table 8) indicated that their contact with external stakeholders took place in collaborative projects (Q_10; 96%), via informal contact keeping (Q_12; 93%), during events fostering exchange and learning (Q_15; 89%), and via expert consulting tasks (Q_19; 78%). The majority of the participants (more than 50% but not more than 75%) collaborated with external stakeholders in executing events (Q_17; 74%), tailoring information to the needs of external stakeholders (Q_20; 74%), supporting the implementation of results (Q_16; 67%), and supervising students in collaboration with external stakeholders (Q_13; 56%). The remaining three statements were chosen by less than 51% of the participants. Those are the execution of events for external stakeholders (Q_18; 48%), jointly using technical infrastructure (Q_11; 41%), and jointly teaching with external stakeholders (Q_14; 30%).

Table 8 KTE activities in which Eawag's scientists engaged in during the past two

'In which of the following knowledge and technology exchange (KTE) activities did you engage in during the past two years? (This can include on-going activities.)'		
Q_10	I was part of **collaborative projects** with external stakeholders	96%
Q_12	I have been **maintaining informal contacts** with external stakeholders	93%
Q_15	I **took part in events that fostered exchange and learning** with external stakeholders	89%
Q_19	I did **expert consulting** for external stakeholders (reports / expertise)	78%
Q_17	I have **executed events in collaboration** with external stakeholders (trainings, workshops, conferences ...)	74%
Q_20	I have been **tailoring information to the needs / context** of external stakeholders	74%
Q_16	I have been **supporting the implementation of results**	67%
Q_13	I have **supervised student projects in collaboration** with external stakeholders	56%
Q_18	I have **executed events for** external stakeholders (trainings, workshops, conferences ...)	48%
Q_11	I have **jointly used technical infrastructure** with external stakeholders	41%
Q_14	I have **jointly taught courses with** external stakeholders	30%

One of the comments in the text box mentions Sandec's activities in setting up and running online courses (Massive Open Online Courses, Small Private Online Courses and Blended Learning Formats) as additional activities the researchers engage in. Another comment from the field of engineering mentions the writing of guidelines for VSA (Verband Schweizer Abwasser- und Gewässerschutzfachleute) and collaborating with universities of applied sciences (UAS).

3.4.3 Comparison of results on pages 3 (Q_2 - Q_9) and 4 (Q_10 - Q_14 and Q_16 - Q_20)

The statements on pages 3 and 4 of the questionnaire are very similar to each other (for results see subchapters 3.4.1 and 3.4.2 respectively). Therefore, this subchapter presents a comparison of the results. The focus of page 3 is on the importance of the listed KTE activities for research. In contrast, page 4 asks the participant to choose all KTE activities he / she has been involved in in the past two years. Table 9 contrasts the values of the T2B for page 3 (Q_2 – Q_9) and page 4 (Q_10 – Q_14 and Q_16 – Q_20). An observation is that the values are in the same range.

Table 9 Comparison of the T2B values of statements Q_2 - Q_9 (page 3) with the frequency of statements Q_10 - Q_14 and Q_16 - Q_20 (page 4)

T2B of the importance of statements Q_2 - Q_9 on page 3			**frequency of statements Q_10 - Q_14 and Q_16 - Q_20 on page 4**		
being part of collaborative projects with external stakeholders	Q_2	86%	96%	Q_10	I was part of collaborative projects with external stakeholders
maintaining informal contacts with external stakeholders	Q_4	85%	93%	Q_12	I have been maintaining informal contacts with external stakeholders
tailoring information to the needs / context of external stakeholders	Q_9	81%	74%	Q_20	I have been tailoring information to the needs / context of external stakeholders
doing expert consulting for external stakeholders (reports / expertise)	Q_8	67%	78%	Q_19	I did expert consulting for external stakeholders (reports / expertise)
supporting the implementation of results	Q_6	61%	67%	Q_16	I have been supporting the implementation of results
organising events (trainings, workshops, conferences ...) for external stakeholders	Q_7	59%	48%	Q_18	I have executed events for external stakeholders (trainings, workshops, conferences ...)
creating opportunities (trainings, workshops, conferences, joint teaching, joint supervision of students ...) for exchange / learning with external stakeholders	Q_5	57%	74%	Q_17	I have executed events in collaboration with external stakeholders (trainings, workshops, conferences ...)
			56%	Q_13	I have supervised student projects in collaboration with external stakeholders
			30%	Q_14	I have jointly taught courses with external stakeholders
jointly using technical infrastructure with external stakeholders	Q_3	50%	41%	Q_11	I have jointly used technical infrastructure with external stakeholders

3.5 Time investment in research, education and KTE (page 5, Q_21)

Page 5 of the questionnaire asked the survey participants to make a statement about their time investments in research, education, and knowledge and technology transfer ("Please select the section of the triangle that is the most suitable reflection of your time investments in research, education and knowledge and technology exchange (KTE) in the past two years.").

More than halve of the scientists (52%, Figure 4) state about themselves that they spend about the same amount of time for research, education, and KTE activities (Figure 3: section 5 = centre of the triangle). The second largest group of scientists (28%) invest about the same amount of time in research and KTE activities but less for educational activities (Figure 3: section 4).

Figure 3 The triangle displays the three mandates, research, education, and knowledge and technology transfer of Eawag (see Table 10 for a description of the seven sections)

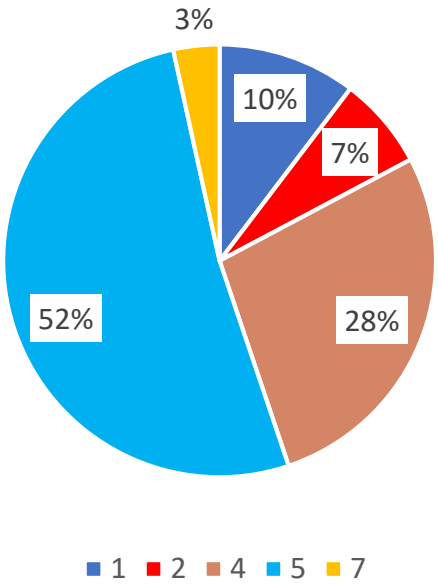

Figure 4 Time investments in different shares of research, education, and KTE of researchers at Eawag: The numbers and colours match with those in Figure 3

Of the remaining five sections of the triangle (Figure 3), two were not chosen by any of the participating scientists (section 3 and 6). Both sections reflect time investments that include a major share of educational activities. Sections 1, 2, and 7 were selected by 10%, 7%, and 3% respectively (Figure 4). A full description of the seven sections can be found in Table 10.

Table 10 Distribution of time invested in research, education and knowledge and technology exchange (KTE)

Section	Research	Education	KTE
1	exclusively or mainly	a little or nor at all	
2	about the same amount of time is used for both		a little or nor at all
3	a little or nor at all	exclusively or mainly	a little or nor at all
4	about the same amount of time is used for research and KTE	a little or nor at all	about the same amount of time is used for research and KTE
5	about the same amount of time is used for all three		
6	a little or nor at all	about the same amount of time is used for both	
7	a little or nor at all		exclusively or mainly

3.6 Necessities for more effectivity (page 6, Q_22 – Q_27 and page 7, Q_28 – Q_33)

The statements on pages 6 and 7 list activities that relate to the needs of the survey participants for an increased effectivity of their KTE activities. While statements Q_28 – Q_33 (page 7) focus on institutional support by Eawag, statements Q_22 – Q_27 (page 6) concentrate on an alteration of the scientific system, interaction with external stakeholders, and the individual skills of the researcher.

Table 11 Overview of the statements Q_22 - Q_27 (page 6 of the questionnaire) on the alteration of the scientific system, interaction with external stakeholders and the individual skills of the researcher in the order of the highest to lowest agreement as rated by the participants of the survey.

No.	statement	Median (MED)	Top 2-Box (T2B)	Bottom 2-Box (B2B)	Normalised Total Score (NTS)
Q_25	... metrics of science impact to include measures of KTE activities so that I can prioritise KTE activities on equal footing with publishing	agree	68%	14%	71
Q_24	... external stakeholders to have allocated time to be embedded within research teams from project onset to completion	agree	63%	11%	67
Q_22	... to have training in science communication	agree - undecided	50%	25%	61
Q_23	... to have more opportunities to engage with external stakeholders	undecided	43%	25%	54
Q_26	... to improve my French language skills	undecided	41%	30%	51
Q_27	... to improve my German language skills	disagree	17%	67%	27
					55

In summary, it can be said that the level of agreement of the scientists varies for statements Q_22 – Q_27 (Table 11). The majority of the participating scientists agree with the two following statements: shifting of the metrics of science impact to include measure of KTE activities (Q_25; MED ‘agree’, T2B 68%, NTS 71) and involving external stakeholders within research projects from onset to completion (Q_24; MED ‘agree’, T2B 63%, NTS 67). Furthermore one out of two scientists (T2B 50%) expressed that they would like to have a training in science communication (Q_22; MED between ‘agree’ and ‘undecided’, NTS 61). In addition, one out of four scientists indicated that they are undecided about this statement. Similarly, about one out of three scientists are undecided whether they would like to have more opportunities for engaging with external stakeholders (Q_23; MED ‘undecided’, T2B 43%, NTS 54). Likewise, the improvement of language skills did not receive very high agreement. Less than half (T2B 41%) of the scientists see a benefit in improving their French language skills (Q_26; MED ‘undecided’, NTS 51) while 30% are undecided and another 30% disagree (B2B). Two-thirds of the scientists (B2B 67%) do not see any benefit for the effectivity of their KTE activities in an improvement of German language skills (Q_27; MED ‘disagree’, T2B 17%, NTS 27).

Overall, the survey takers are undecided about most statements that focus on institutional support by Eawag (Table 12, Q_28 – Q_33, page 7 of the questionnaire). A clear exception is statement Q_30: Three out of four scientists would like Eawag to support them with dedicated funding for KTE

activities (MED 'agree', T2B 75%, NTS 71). The service of translation and interpreting is rated as beneficial by 50% of the scientists (Q_33; MED between 'agree' and 'undecided', T2B 50%, NTS 58). Undecided but with a tendency to agreement are the participating scientists about rewards for successful KTE activities (Q_29; MED 'undecided', T2B 46%, NTS 63). Coordination of KTE activities (Q_31; MED 'undecided', T2B 39%, NTS 52), more administrative support (Q_28; MED 'undecided', T2B 29%, NTS 47), and support with finding suitable external stakeholders to collaborate with (Q_32; MED 'undecided', T2B 25%, NTS 45) can be summarised as follows. All three items have about one third of the votes in the T2B, one third of the votes in the box 'undecided', and one third of the votes the B2B, respectively.

Table 12 Overview of the statements Q_28 - Q_33 (page 7 of the questionnaire) focussing on institutional support by Eawag in the order of the highest to lowest agreement as rated by the participants of the survey.

No.	statement	Median (MED)	Top 2-Box (T2B)	Bottom 2-Box (B2B)	Normalised Total Score (NTS)
Q_30	... to support me with dedicated funding	agree	75%	14%	71
Q_33	... to provide a translation / interpreting service	agree - undecided	50%	21%	58
Q_29	... to reward me for successful KTE activities	undecided	46%	18%	63
Q_31	... to coordinate KTE activities	undecided	39%	25%	52
Q_28	... to provide more administrative support so that I can focus more time on KTE activities	undecided	29%	36%	47
Q_32	... to support me with finding suitable external stakeholders	undecided	25%	43%	45
					56

A comparison of the normalised sum of the NTS's for statements focussing on institutional support by Eawag (Q_28 – Q_33) and on an alteration of the scientific system, interaction with external stakeholders, and the individual skills of the researchers (Q_22 – Q_27) shows that the two values are almost the same.

The text boxes on both pages contained additional statements (all with an indication of high agreement) with ideas on how to enhance the effectivity of KTE activities. Furthermore, some ideas presented on the last page of the survey (page 10, see Appendix A) correspond with the statements in this section. The ideas can be summarised as follows.
One suggestion for an improved effectivity of KTE activities is to employ staff who has a more applied focus like Christine Weber (RGL, Surf) and Marc Böhler (RGL, Eng).
One participating scientist mentions that it would be helpful to be able to assess "the impact of online learning". The commentator explains, "that conventional impact measurement metrics are not helpful" in this regard.
Moreover, ideas were presented on how Eawag could dedicate funds to support KTE activities. The first idea is "to provide targeted funding for collaboration with" universities of applied sciences (UAS). The second idea is to reward successful KTE activities "with resources to do research (e.g. PhD students)". Thirdly, one scientists suggests that it "might make sense" to provide funding "for smaller activities". Examples mentioned for smaller activities are professional recording of a conference,

proofreading of final project reports, and a deficit guarantee.
Besides, two comments highlight existing programmes and examples. One scientist suggests that targeted (KTE) funding for larger projects "should go through Innosuisse" (Innosuisse 2020). The writer of the comment defines a large project by consisting of partners from Eawag, a university of applied sciences, and two to three companies. Another scientist elaborates on the idea to initiate or join a "structured industrial innovation programme". An example mentioned for the latter is the UK based initiative 'Stream – Shaping careers, delivering innovation'. The Engineering and Physical Sciences Research Council (EPSRC) as well as different companies sponsor research projects in the water sector (Stream-IDC 2021).
Concerning the focus of future KTE activities, one researcher suggests "harvesting the business potential from PhD research". The scientist refers to an Eawag Seminar with Helge Daebel and to the practice in other countries like Singapore. Furthermore, the comment points out that a new focus on PhD research should be "coordinated at ETH-level" but that a start could be to ask each PhD student to "write 1-2 pages with concrete (potential) practical applications or [to] make a small teaser which industrial partners / [an] innovation commission could look at".
Furthermore, at least one scientist does not see a need to coordinate KTE activities on the institutional level. This statement is justified by the observation that there is also no coordination offered for SNF or EU proposals.

3.7 Motivators for KTE activities (page 8, Q_34 – Q_41)

Page 8 of the questionnaire lists motivators for KTE activities. The superior question is "What motivates you to engage in knowledge and technology exchange (KTE) activities?"

Table 13 Overview of the statements Q_34 - Q_41 (page 8 of the questionnaire) in the order of the highest importance as rated by the participants of the survey.

No.	statement	Median (MED)	Top 2-Box (T2B)	Bottom 2-Box (B2B)	Normalised Total Score (NTS)
Q_34	promoting diffusion of research findings	strongly agree	93%	4%	89
Q_36	gaining additional insight in my own research field (for research projects and / or education)	agree	86%	7%	80
Q_37	conducting applied research is only possible in collaboration	agree	86%	7%	80
Q_41	assisting the institutional mission	agree	82%	4%	76
Q_35	improving the image of science	agree	59%	22%	66
Q_38	securing additional funds for research	undecided	39%	36%	49
Q_40	achieving recognition	undecided	33%	37%	47
Q_39	gaining access to technological equipment of the external stakeholder	undecided	37%	48%	43
					66

The participating scientists of the survey show clear agreement with five (Q_34 – Q_37 and Q-41) of the eight statements (Table 13). The median of the remaining three statements (Q_38 – Q_40) is in the category 'undecided'. More than 90% (T2B) of the participants are engaged in KTE activities in order to promote the diffusion of research findings (Q_34; MED 'strongly agree', T2B 93%, NTS 89).

Furthermore the participating scientists are motivated by gaining additional insight into their research field (Q_36; MED 'agree', T2B 86%, NTS 80), the fact that applied research is only possible in collaboration (Q_37; MED 'agree', T2B 86%, NTS 80), and that they assist the institutional mission in this way (Q_41; MED 'agree', T2B 82%, NTS 76). For the following three statements (Q_38 – Q_40), the box 'strongly agree' was not chosen at all or only once (statement Q_38). Furthermore, there is about one-third of the votes in the T2B, the box 'undecided' and the B2B for the statement of securing additional funds for research (Q_38; MED 'undecided', T2B 39%, NTS 49): The same applies to the statement of achieving recognition (Q_40; MED 'undecided', T2B 33%, NTS 47). The gain of access to technological equipment (Q_39; MED 'undecided', T2B 37%, NTS 43) is disagreed with by almost half of the participants (B2B 48%).

In addition to the pre-formulated statements, other statements reflecting intrinsic motivation were added. One survey taker is highly motivated by advancing "the level of practice to enable more effective (…) solutions". Two other survey takers mentioned that they are (highly) motivated by the fact that KTE activities allow them to "having an impact (…)" and "influencing (…) policy making". Likewise, the last page of the questionnaire contains comments referring to motivation. One participant expresses contentment with the ability to "work at the research-practice interface" and the absence of pressure to publish in journals with a high impact factor. Furthermore, the participant utters the hope that other researchers at Eawag will have the possibility to focus more on KTE as well. Another comment highlights the scientific freedom of researchers. The recommendation of the researcher is to use the 'practical relevance' and the applicability of a topic as method of selection rather than "publishability, pure scientific curiosity," and career possibilities.

4 Discussion

This chapter discusses the main results of the previous chapter. The first two subchapters (chapters 4.1 and 4.2) focus on determining factors. Subsequently, subchapter 4.3 -4.5 deal with the topics importance and increased effectivity of, and motivation for KTE activities. Whenever possible the findings of this survey are put in contrast to the results of a previous survey at Eawag. In 2018, a 'Personalbefragung' was conducted at Eawag. The corresponding questionnaire had been send to all employees of Eawag with a workload of at least 30%. It was filled out by 81 % of the recipients. In addition to many other topics the questionnaire encompassed several questions about knowledge and technology transfer (KTT) at Eawag (Wissens- und Technologietransfer) (pages 39 – 41 in Eawag and Kunz&Huber (2018)). In the same year, Simon Maag compiled a list of ideas to support the KTE activities of Eawag's researchers (Maag 2018). Some of these ideas are taken up below as well.

4.1 Response rate

The low response rate (Subchapter 3.1, Figure 1) of the KTE survey is implicating a high non-response rate. The reasons for non-response can be manifold. For one thing it can be expected that people who are interested in a topic are more likely to participate in a survey on this topic (Groves and Couper 1998). Which would lead in the case of this survey to the conclusion that only a small share of scientists at Eawag is interested in KTE activities. The differences in shares of scientists with experience in KTE for subgroups X (27%) and A + B (93%) (Subchapter 3.2) can be rated as an indication for the evidence of the prior assertion. Furthermore, the survey 'Personalbefragung' at Eawag revealed that the consent with the statement that all employees are supporting KTE activities is mediocre (4.3 / 7) (Eawag and Kunz&Huber 2018). However, it has to be kept in mind that there are many other possible reasons for non-response. Another reason can be little expectations in the outcome of the survey (Weisberg (2005) as cited by Adua and Sharp (2010)). Furthermore, it could also be shortage of time or other reasons. In the case of the KTE Survey at Eawag, a further reason could be of relevance. The survey 'Personalbefragung' showed that 53% of the participants were

denying the question whether there are any aspects of knowledge and technology transfer (KTT) at Eawag that are implemented inadequately (Eawag and Kunz&Huber 2018). Due to this number, another possible reason for non-response in the current survey could be a general satisfaction with the possibilities for and support of KTE activities. Despite some hints for the relevance of certain reasons for non-response, it has to be emphasised that there is no certainty for any of them. Further research specifically on this topic would be needed in order to prove any of the possible reasons.

Regardless of the reasons for non-response, due to the small completion rate of the survey the results should be treated with caution. This includes refraining from making generalisations (Bethlehem and Biffignandy 2012).

4.2 Difference between subgroups

The findings from the applications of the Mann Whitney U test allow drawing the conclusion that the rate of importance, needs and motivators for KTE activities are independent from the determining factors of the subgroups. The determining factors are the 'mode of employment' for subgroups A (permanent contract) versus B (fixed-term contract) and 'prior experience outside of academia' for subgroups A.1 (prior experience outside of academia, permanent contract) versus A.2 (no prior experience outside of academia, permanent contract). These results lead to the deduction that all recommendations made in the following paragraphs apply to all groups of scientists in the same way.

4.3 Importance

The results presented in subchapter 3.4.1 show that KTE activities done in cooperation with external stakeholders (Q_2 – Q_6, Table 6) are of equal importance as KTE activities tailored to external stakeholders (Q_7 – Q_9, Table 7) for the research of the participating scientists at Eawag. The prior statement is based on the fact that the normalised sums of the NTS in both Table 6 and Table 7 are almost the same. In addition, the rating for the individual items is in a similar range for most items (e.g. the median is categorised at least as 'important' for all but one statement). Therefore, there is only little evidence for the exclusion of KTE activities from being supported. Rather on the contrary, several scientists mentioned additional KTE activities of importance in the free text box. Beyond this, the results on KTE activities Eawag's researchers were engaged in during the past two years (subchapter 3.4.2) point into the same direction. It stands out that the scientists conduct many different KTE activities. Therefore, a recommendation for Eawag is to offer support for a wide range of KTE activities instead of a small selection. Besides that, the comparison (subchapter 3.4.3, Table 9) of the results in subchapters 3.4.1 and 3.4.2 shows that the share of participating researchers who are conducting a certain KTE activity matches the indicated importance of it in many cases. Due to this observation, it seems justifiable to conclude that researchers have possibilities to engage in KTE activities that are of high importance for their research. This is also shown in the research of Maag (2018) who listed a couple of resources that are available at Eawag. Nevertheless, if specific KTE activities should be supported it is advisable to focus on those that have the greatest mismatch between 'importance' (Q_2 – Q_9) and 'actual engagement' (Q_10 - Q_14 and Q_16 - Q_20). These are 'tailoring information to the needs / context of external stakeholders' (Q_9 and Q_20) and 'organising events (trainings, workshops, conferences ...) for external stakeholders' (Q_7 and Q_18).

4.4 Increased effectivity

Suggestions for measures to increase the effectivity of KTE activities at Eawag can be made based on the results presented in subchapter 3.6. A comparison of the normalised sum of the NTS's for statements focussing on institutional support by Eawag (Q_28 – Q_33) and on an alteration of the scientific system, interaction with external stakeholders, and the individual skills of the researchers (Q_22 – Q_27) shows that the two values are almost the same. This result shows that the researchers do not prefer the items of one Likert scale over the other. Nonetheless, their agreement with certain

statements within the two scales differ. This observation results in several aspects that could be prioritised in decisions for additional support.

In terms of institutional support, a majority of the participating scientists pointed out that dedicated funding (Q_30) would increase the effectivity of their KTE activities. In addition, a couple of comments (see end of chapter 3.6) made by the survey takers refer to this aspect. Firstly, several researchers advance concrete ideas of KTE related activities that could benefit from the provision of additional funds. These ideas include funding subtasks instead of complete projects. The same principle can be found in literature. For example, Cvitanovic et al. (2015) suggest that resources could be dedicated specifically to those activities of projects that deal with stakeholder involvement. Other aspects of setting financial incentives, like e.g. seed grants, are described by Maag (2018).
Secondly, two scientists refer to existing programmes in Switzerland (Innosuisse) and abroad ('Stream – Shaping careers, delivering innovation'). Similar as above, these suggestions are proposed by other scholars as well. Young and Freytag (2020) mention the programme 'Industrial Researcher' by the Innovation Fund Denmark (IFD) as an example for an initiative that supports co-production (IFD 2020a). The IFD gives funds (up to 50% of the expenses) to the partners in 'practice' and 'science' if they employ a researcher (e.g. PhD student or postdoc) to work on a project that benefits both partners as well as the Danish society (IFD 2019, 2020b). Based on these findings, a desk research on Swiss programmes, opportunities for cooperation, and experiences in other countries could give valuable insights into concrete possibilities for Eawag's researchers.
Despite this proposition, it has to be mentioned that the indicated preference for more dedicated funds is in contrast to the result of the Personalbefragung. In 2018, the survey takers were asked to give recommendations on how knowledge and technology transfer could be improved. Only 4% of the participants indicated a need for more resources (Eawag and Kunz&Huber 2018). The reasons for this shift are not obvious from the present data. Two possible reasons are the high non-response in the current survey and the mode of the question: 5-point Likert scale with pre-formulated items (current survey) versus a free text box (Personalbefragung 2018). In spite of the opposing findings, it is expected that researchers would welcome additional funds. Hence, uncovering additional opportunities could be beneficial.

Another finding in the Likert scale focussing on institutional support (Q_28 – Q_33) is that at least half of the survey takers see a benefit in having translation / interpreting service (Q_33). It is noticeable that the number of participants (Appendix A) who agree with this statement (T2B 14 participants) is about the same as for the two items on improved language skills (T2B for Q_26 and Q_27 combined 15 participants). The results do not allow prioritising one option over the other. In addition, literature on the influence of a translation / interpreting service or improved language skills on the effectiveness of KTE activities seems to be rare. Because a scientific basis is missing, no specific recommendation other than doing more research in order to answer this question can be made.

Concerning an increased effectivity of interaction with external stakeholders, a majority of survey takers indicated that that they would like to have options that allow the integration of external stakeholders in projects from the beginning. The benefits of jointly developed projects by all stakeholders are confirmed by several authors (Cvitanovic et al. 2015; Young and Freytag 2020; Beier et al. 2017; Wyborn et al. 2019). In this regard, a recommendation is to find out about existing measures or possibilities to initiate new measures for implementation.

With regard to their personal abilities, it stands out that half of the participants indicated that it would be valuable for their work to be better trained in science communication (Q_22). It is assumed that this skill supports the recommendation made in subchapter 4.3 regarding the editing of

information to the needs / context of external stakeholders (Q_9 and Q_20). Scholars like Bammer (2020), Rodari and Weitkamp (2015), and Scalice et al. (2019) report about their experiences with science communication trainings and its benefits. In addition, Maag (2018) compiled a list of already available resources at Eawag and other institutions that can support developing the necessary skills. The findings of all mentioned authors can serve as a starting point for further investigations on how this could be of value for Eawag's researchers.

Furthermore, the majority of scientists would like the scientific system to be altered in order to include measures for KTE activities (Q_25). This concern is supported by the work of Schmoch and Schubert (2009). The two authors point out that all areas of responsibility of the scientists should be included in the measures of scientific performance. They explain that setting incentives for only a few of the areas of responsibility prevents the achievement of the best overall results. This is because researchers tend to base their decisions for time investments on existing incentives instead of their individual talents and interests (Schmoch and Schubert 2009). Since an individual institution like Eawag might not be able to change a globally applied approach Maag (2018) suggests coalition building with institutions that have a similar mind-set and lobbying for a change. Nonetheless, Eawag could set an example and start implementing a scientific system that includes KTE activities. In the past, several groups of researchers have already made suggestions for the evaluation of KTE activities. The objects of evaluation range from institutions (Ishizaka et al. 2020; Schmoch and Schubert 2009; Holi, Wickramasinghe, and Van Leeuven 2008) to projects (Krause and Schupp 2019; Treffeisen, Grosfeld, and Kuhlmann 2017), and individual scientists (Maag et al. 2018). In order to develop a useful tool for Eawag's needs an in-depth literature review and more research are needed.

4.5 Motivation

A close look at the results of factors that motivate researchers to engage in KTE activities (subchapter 3.7) reveals that statements with a higher NTS are those that could be categorised as intrinsic motivators. In addition, the comments in the free text box are also mainly intrinsic motivators. In contrast, the statements that are agreed with by fewer scientists are those that could be categorised as extrinsic motivators. This results in two starting points for Eawag to foster the motivation of researchers for KTE activities. One option is to cultivate the intrinsic motivation of the scientists. Some ideas on how this could be done were summarised briefly by Barreiro and Treglown (2020). The other option is to put the focus on extrinsic motivators. In this regard, it would be relevant to know the reasons for the smaller agreement of the participating researchers. An expected outcome is that strong extrinsic motivators are lacking. One of the questions in the survey 'Personalbefragung' showed as well that a higher appreciation of KTE activities could be a benefit. Comments with this content were made by 9% of the survey participants (Eawag and Kunz&Huber 2018). Again, it should be kept in mind that the mode of the question were different in the two surveys: 5-point Likert scale with pre-formulated items (current survey) versus a free text box (Personalbefragung 2018) which makes it difficult to compare the absolute numbers. Nevertheless, a higher appreciation could be beneficial. In practice, a couple of recommendations made above like providing more financial resources for KTE activities or altering the metric system (subchapter 4.4) could serve as extrinsic motivators for more effective KTE activities.

5 Conclusion

The analysis of the results of the KTE Survey conducted at Eawag reveals expedient information about the group of participating scientists. Due to the small completion rate is not advisable to generalise the findings and use them as the only basis for deciding on supportive measures of KTE activities at Eawag (chapter 4.1). Nevertheless, the findings helped to identify aspects of relevance for the KTE activities of Eawag's reseachers. Thus, they support the decision making for the focus of future research activities in order to verify the findings of this survey.

Due to the finding that the difference between the results for the subgroups was unincisive (chapter 4.2), it seems to be likely that the different groups of researchers at Eawag are going to profit equally from eventual measures. Furthermore, the results show that many different KTE activities are important for the research of the scientists (chapter 4.3). Therefore, supportive measures should focus on a range KTE activities. In addition, the study revealed that many scientists can engage in KTE activities that are a benefit for their own research (chapter 4.3). This positive finding shows that the conditions in general and at Eawag specifically allow the conduction of meaningful KTE activities.

Beyond, the study shows that the scientists currently conduct KTE activities mainly based on an intrinsic motivation (chapter 4.5). An obvious measure could therefore be to foster the intrinsic motivation of all scientists. Nonetheless, setting incentives that serve as extrinsic motivators are recommendable as well. This conclusion can be made based on the measures that have been rated as helpful to increase the effectivity of KTE activities by the participating scientists (chapter 4.4). They include an alteration of the metrics of science, the embedment of external stakeholders in research projects over the entire duration, and more dedicated funds. While an individual institution is unlikely to achieve a major structural change like the alteration of the metrics of science, Eawag could support the implementation of the other two measures by allocating (more) funds for them in future. In addition, awareness among researchers can be raised for existing measures that support the co-production of knowledge. Other measures that go beyond the scope of Eawag as an individual institution like altering the metric system or funding initiatives that focus on knowledge co-production can be pursued by lobbying in cooperation with other research institutions. A motivating factor for the latter activities is that the overall best results can be achieved when the metrics of science include all activities: research, KTE activities and education equally.

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Appendix A

The following subchapters give an overview over the numbers of participants who have chosen a certain answer. All questions that are part of the questionnaire are highlighted in light blue. The answers for the questions on the pages 3, 6, 7, and 8 are coloured additionally in green and red. The aim is to facilitate the readability: the highest score(s) is(are) coloured in green the lowest score(s) in red. All entries that have been added by the participant of the survey are marked in yellow.

Page 2 “In the last two years, have you been involved in any KTE activities that match the above definition?”

yes	30
no	10

Page 3 Question “How important are the following knowledge and technology exchange (KTE) activities for your research?”

Part a “- activities that are done in cooperation with external stakeholders –“

	4 - very important	3 - important	2 - moderately important	1 - slightly important	0 - unimportant
being part of collaborative projects with external stakeholders	17	7	2	1	1
jointly using technical infrastructure with external stakeholders	4	10	3	1	10
maintaining informal contacts with external stakeholders	15	8	2	0	2
creating opportunities (trainings, workshops, conferences, joint teaching, joint supervision of students ...) for exchange / learning with external stakeholders	8	8	6	4	2
supporting the implementation of results	11	6	7	3	1
Participating in new technical guidelines		1			
Promoting new fields of focus based on new scientific knowlege (e.g. climate change adaptation).		1			
Providing scientific support / input in working groups		1			

Part b - activities that are tailored to external stakeholders -

	4 - very important	3 - important	2 - moderately important	1 - slightly important	0 - unimportant
organising events (trainings, workshops, conferences ...) for external stakeholders	12	4	4	7	0
doing expert consulting for external stakeholders (reports / expertise)	8	10	5	4	0
tailoring information to the needs / context of external stakeholders	10	12	3	2	0
Personal participating in external events	1				
co-creating guidelines		1			

Page 4 Question “In which of the following knowledge and technology exchange (KTE) activities did you engage in during the past two years? (This can include on-going activities.)

I was part of collaborative projects with external stakeholders	26
I have jointly used technical infrastructure with external stakeholders	11
I have been maintaining informal contacts with external stakeholders	25
I have supervised student projects in collaboration with external stakeholders	15
I have jointly taught courses with external stakeholders	8
I took part in events that fostered exchange and learning with external stakeholders	24
I have been supporting the implementation of results	18
I have executed events in collaboration with external stakeholders (trainings, workshops, conferences ...)	20
I have executed events for external stakeholders (trainings, workshops, conferences ...)	13
I did consulting for external stakeholders (reports / expertise)	21
I have been tailoring information to the needs / context of external stakeholders	20
the list ist quite long....	1

Part b: Free field

Eawag Sandec expertise in:; Massive Open Online Courses; Small Private Online Courses; Blended learning formats
Very important in my field (engineering). Very straightforward to implement, e.g. actively writing guidelines for VSA, setting standards and implementing ideas in practice. I have been doing this since my start at Eawag as a PhD student in late 2000.; ; HOWEVER, in recent years, the gap between science and practice has been widening to very critical levels in my field. Meaning: what I am investigating scientifically is SO FAR OUT from practical concerns, that it is more and more challenging to do "good" science and consulting at the same time. This can also be critical for younger colleagues (on tenure track), because for some work we rely heavily on real-world data from exisiting wastewater systems. And good collaboration.; ; We urgently need some idea how to fix this. Closer collaboration with UAS, VSA Plattform, ...

Page 5 Question “Please select the section of the triangle that is the most suitable reflection of your time investments in research, education and knowledge and technology exchange (KTE) in the past two years.”

1	3
2	2
3	0
4	8
5	15
6	0
7	1

Page 6 Question “Please indicate your level of agreement with the following sentences. In order to engage more effectively in knowledge and technology exchange (KTE) activities, I would like ...”

	4 – strongly agree	3 - agree	2 - undecided	1 - disagree	0 – strongly disagree
... to have training in science communication	5	9	7	7	0
... to have more opportunities to engage with external stakeholders	1	11	9	5	2
... external stakeholders to have allocated time to be embedded within research teams from project onset to completion	5	12	7	2	1
... metrics of science impact to include measures of KTE activities so that I can prioritise KTE activities on equal footing with publishing	11	8	5	1	3
... to improve my French language skills	3	8	8	3	5
... to improve my German language skills	1	3	4	5	11
Have more scientist with a profile like Christine Weber...	1				
structured Industrial innovation program, e.g. http://www.stream-idc.net/about.php	1				

Page 7 Question “Please indicate your level of agreement with the following sentences. Regarding knowledge and technology exchange (KTE) activities, I would like Eawag ...”

	4 – strongly agree	3 - agree	2 - undecided	1 - disagree	0 – strongly disagree
... to provide more administrative support so that I can focus on KTE activities	2	6	10	7	3
... to reward me for successful KTE activities	7	6	10	4	1
... to provide targeted funding for specified KTE activities	8	13	3	3	1
... to coordinate KTE activities	0	11	10	5	2
... to support me with finding suitable external stakeholders	1	6	9	10	2
... to provide a translation / interpreting service	3	11	8	4	2
To have more people with a stronger applied focus (e.g. Marc Böhler)	1				
... to provide targeted funding for collaboration with UAS	1				
... to reward me for successful KTE activities with resources to do research (e.g. PhD students)	1				

Page 8 Question "What motivates you to engage in knowledge and technology exchange (KTE) activities?"

	4 – strongly agree	3 - agree	2 - undecided	1 - disagree	0 – strongly disagree
promoting the diffusion of research findings	19	7	1	1	0
improving the image of science	8	8	5	5	1
gaining additional insight in my own research field (for research projects and / or education)	12	12	2	2	0
conducting applied research is only possible in collaboration with external stakeholders	13	11	2	1	1
securing additional funds for research	1	10	7	7	3
gaining access to technological equipment of the external stakeholders	0	10	4	8	5
achieving recognition	0	9	8	8	2
assisting the institutional mission	7	16	4	1	0
Having an impact and making a difference...	1				
influencing management and policy making		1			
advance the level of practice to enable more effective ("the right") solutions	1				
part of our mandate	1				

Page 9 Questions

Part a: "Do you have prior experience (>1 year) outside of academia?"

yes	17
no	12

Part b: "What is your current mode of employment?"

unlimited	20
fixed-term	9

Part c: "Are you currently working in a leading position (e.g. as group leader)?"

yes	21
no	8

Page 10 “Please use the space below to mention anything else that would help to improve the knowledge and technology exchange (KTE) at Eawag.”

We are grapling with the issue of how to assess the impact of online learning, where we find that conventional impact measurement metrics are not helpful.
We need to accept as a part of working at Eawag that we need to expose ourselves to practice. This means spending time with people - not just within the confines of a project, but being personally engaged in practice organisation (SVGW, VSA, Pusch, ...). Beeing approachable and personally known by people is extremely important in Switzerland. This also means that language matters.
I think that targeted funding to improve innovation (implementing scientific knowledge in practice) should go through Innosuisse. It does not make sense that eawag hires program officers, writes guidelines, checks financial and accounting stuff...; ; Initiatives like this ; https://www.innosuisse.ch/inno/en/home/promotion-initiatives/flagship-initiative.html; (e.g. Eawag+ UAS + 2-3 companies) ; are great and should be supported.; ; "... to provide targeted funding for specified KTE activities"; might make sense for smaller activities, e.g. provide budget to professionally record a conference, proof-reading of final project reports, give a deficit guarantee, ... ; ; ... to coordinate KTE activities; do not see why coordination is needed here. We also do not provide TOP-level coordination for SNF or EU proposals.; ; an open point is harvesting the business potential from PhD research => discussion at Eawag Seminar with Helge Daebel. ; This is much more structured in other countries, e.g. Singapore. BUT should probably be coordinated at ETH-level. We could enter the discussion low-level, though, e.g. each PhD should write 1-2 pages with concrete (potential) practical applications or make a small teaser which industrial partners/innovation commission could look at...
In view of a) the challenges our society faces now and in the near future and b) the possibilites and freedom that we are given to opt a choice concerning the direction we focus our professional research, we should always orient our work on topics of high practical relevance. Climate, biodiversity, ending resources raise so many interesting research question, that publishability, pure scientific curiosity and carreer ought be recognized as secondary to relevance and practical applicability.
I really appreciate to work at the research practice interface. We can concentrate fully on involved stakeholder and knowledge transfer, without the pressure of publications in scientific papers. For us, articles in technical magazines or the documentation of successful workshops for example also count.; I wish, that this situation will come true also for other researchers at Eawag, who'd like to concentrate more on KTE.