Secondary Students Intrinsic Motivation during Multidisciplinary STEAM projects

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ABSTRACT

Education is usually organized along the line of mono-disciplines. It is however argued that a focus on solving problems, designing and advising for clients will be more meaningful for students and will enhance their motivation for Science, Technology, Engineering and Mathematics subjects and careers. Therefore, the Dutch network of Technasia schools have positioned Integrative STEAM projects for clients central in their curriculum.

Usually these projects are related to one discipline and conducted by students with a science-oriented profile. In a pilot, 8 schools developed and conducted Multidisciplinary STEAM Projects for pupils in grade 9 to 11 using social cooperative approaches such Jigsaw and perspective-based question prompts that scaffold multi-disciplinary ways of thinking.

The self-determination theory links intrinsic motivation with the presence of autonomy, relatedness, perceived competences. The theory also links the way students perceive the relevance of their learning activities to motivation. Therefore the Intrinsic Motivation Inventory (IMI) questionnaire was used to determine half-way and after the project of 182 students their interest and enjoyment as well perceived competence, effort, pressure, perceived choice, value/usefulness and relatedness. For relatedness to peers and to the client the original statements from IMI were adapted. The results show that intrinsic motivation was slightly positive on average, while relatedness between teammates was positive and pressure low. Students experienced working from different disciplines as valuable. It is suggested to develop new items to measure relatedness to the client as those based on the original IMI where not able to measure this construct well.

Key Words: Self-determination theory, Motivation, Multidisciplinary Projects, Secondary Design and Technology Education, Integrative STEAM, Jigsaw

1. INTRODUCTION

Motivation for Science, Technology, Engineering and Mathematics (STEM) is crucial for the development of perseverance and to perform well. However, many studies show that motivation

for STEM subjects tends to decline during secondary education (Crawford 2014: Potvin & Hasni 2014, Barmby et al. 2008; Teppo, Soobard, & Rannikmäe, 2021). Among the reasons given, it is thought that many students are not particularly interested in STEM when subjects are given in a rather abstract, mono-disciplinary way (Teppo et al., 2021). This approach would work well with personalities that John Holland defines as having realistic or abstract preferences, but does not seem well suited for those who are driven by social or artistic preferences (Klapwijk & Rommes, 2009).

Integrated STEAM (science, technology, engineering, arts and mathematics) programs may provide a richer image, enable students to develop a great many skills like entrepreneurship and creativity that are not present in the traditional, mono-disciplinary subjects and this may increase student's motivation for learning. Based on this idea, the Dutch Curriculum has undergone a reform and two integrated STEAM subjects have been introduced: Nature, Life and Technology and Research & Design. Both subjects emphasize the value of learning and applying knowledge of science and technology for social, entrepreneurial and creative questions, therefore the term STEAM is more appropriate than STEM.

The subject Research & Design is especially unique as all learning is based on projects developed by teachers in conjunction with local organizations and in the later grades by students themselves. The client will present the problem at the start of the project and secondary students will use their expertise to propose solutions. Usually, the projects are developed around one specific profession or discipline, e.g. an architect. Currently more than 100 Dutch secondary schools that are part of the Technasium network offer the subject for pupils aged 12 to 18.

In a pilot, Technasium teachers developed projects that take more than one profession or discipline into account. In these projects, students were asked to combine insights from different disciplines to shed light on the question from the client.

Although it is often conjectured that Integrated STEAM leads to an enhanced motivation, systematic research is needed. Vossen and colleagues studied motivation of Dutch Research & Design students, but their study was not related to specific Integrated STEAM projects (Vossen, Henze, Rippe, Van Driel, & De Vries, 2018). The aim of our study is to measure the intrinsic motivation of Dutch pupils for Integrated STEAM projects using a multidisciplinary approach. Specifically, the researchers answered the question what is the level of motivation of the students during and after doing an integrated multidisciplinary STEAM project in terms of a) interest and enjoyment, b) perceived competence, c) effort, d) pressure, e) perceived choice, d) value/usefulness, and relatedness (Centre for Self-Determination Theory, 2023). Also, the aim was to make an existing questionnaire on motivation suitable for use in the context of multidisciplinary STEAM projects for clients.

2. LITERATURE REVIEW

Previous research on academic motivation has produced a number of theoretical frameworks. All of these theories state that motivation involves internal processes that initiate and maintain goal-directed behaviours (Pintrich & Zusho, 2002). According to the Expectancy-Value theory

(Wigfield & Eccles, 2000) motivation is related to students' beliefs about themselves (expectations) and to the value students assign to certain tasks. Wigfield and Eccles state that the motivation to perform tasks increases when the expectation of success increases, students expect that they will succeed in performing the task well, and the task is perceived as valuable.

Most theories of motivation distinguish between different types of motivation. The self-determination theory (Ryan & Deci, 2017) distinguishes intrinsic from extrinsic motivation. Intrinsic motivation is about the interest and pleasure in the learning activity itself ("I enjoy doing the task), extrinsic motivation is about what doing the task will yield, you can think of a reward, but also the value for someone's personal goals, now and in the future or the value for a client, users or society. Integrated STEAM projects are expected to lead to both types of motivation. Students may enjoy the activities as such and experience the relevance of STEAM as they solve issues for local clients and society.

Self-determination theory links intrinsic motivation with the presence of autonomy, relatedness and perceived competences. These are considered basic needs that need to be met in order to be motivated to learn. A series of qualitative case studies into design education in primary schools (Roël-Looijenga, 2021) and a quantitative study in grade nine (Chiu, Chai, Williams, & Lin, 2021) confirm that these needs are relevant for integrated STEAM projects. However, autonomy is not always beneficial, namely when students are given too much freedom of choice and are unable to work purposefully in a design project (Roël-Looijenga, 2021). From social innovation theory, it is also known that to achieve social innovations these basic needs need to be met. Avelino, Dumitru, Cipolla, Kunze, & Wittmayer (2020) demonstrate this for sustainable innovations and describe that innovations were kept going – even going against the grain – when basic needs where met.

Feelings of fear and stress that students may have also play a role. Fear can hinder learning, lower performance and reduce the enjoyment of learning. Feelings of anxiety are a problem for STEM, but maybe less so for STEAM. Anxiety is more common among girls although differences seem to be small, e.g. in the context of math (Dowker, Sarkar, & Looi, 2016) or during integrated STEAM activities (Vossen, Henze, Rippe, Van Driel, & De Vries, 2018).

3. METHODOLOGY

3.1. Participants

The participants were ten teachers and their secondary school students (grade 9 to 11) of eight Technasium schools across the Netherlands. Data were collected from September 2022 to June 2023. Most students followed the Research & Design track and had prior experience in STEAM project work. In total, 182 unique students filled in a complete or almost complete questionnaire and 92 of these filled in both the mid- and post-questionnaire. Two teachers conducted the multidisciplinary STEAM projects with non-Research & Design students, 49 unique respondents had no prior experience with STEAM projects. Students from grade 9 to 11 with different study profiles and education levels were involved. In the Dutch system, students select a profile at the start of grade 11. Nature and Technology and Nature and Health profiles focus on science, the

Economy and Society profile on gamma studies and the Culture and Society profile on Humanities. The aim was to involve students with different profiles in the multidisciplinary projects. However, most schools did not achieve a balanced mix of profiles. Participants came from the VWO level (prepares for universities) as well as the HAVO level (prepares for universities of applied sciences).

Table 1.
Participants.

Category		Mid-questionnaire	Post-questionnaire
Gender	Boys	105	96
	Girls	45	35
	Other, Don't want to tell	6	5
Track	Research & Design	130	101
	Non Research & Design	26	35
Profile	Nature & Technology	67	53
	Nature & Health	39	33
	Economy & Society	39	45
	Culture & Society	11	5
Grade	9	91	60
	10 &11	57	69
	Unknown (9-11)	8	7
Total		156	136

3.2. Multidisciplinary STEAM projects

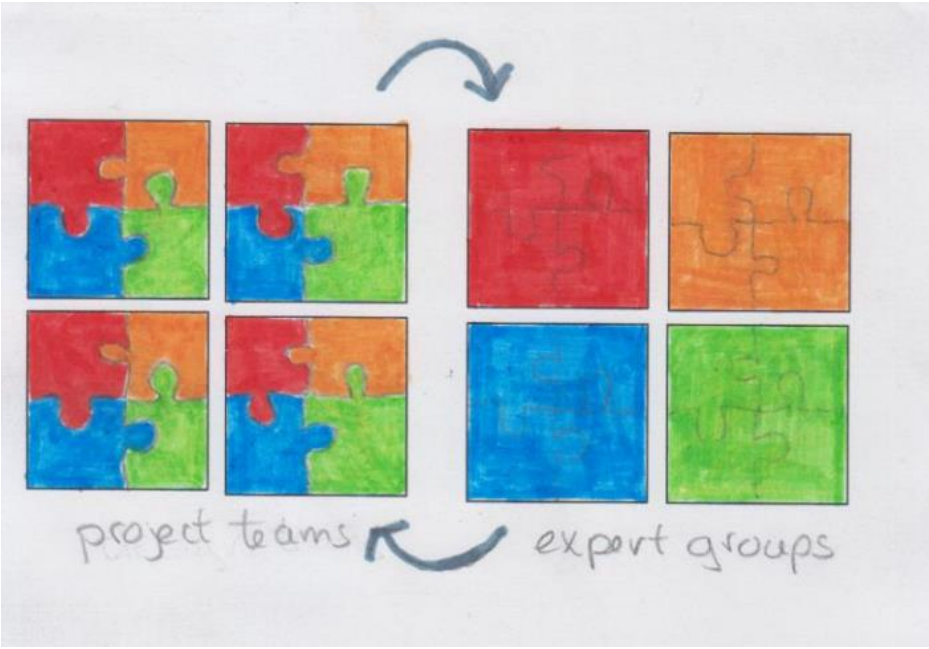
In the educational philosophy of Technasium, teachers develop R&D projects with local clients and experts. To obtain ecological validity, this procedure was also followed in this research and each school conducted a unique STEM project, including a project on local hydrogen use, meat substitutes, repurposing old school buildings and local recycling of waste in a care institute.

Normally a Technasium project is only related to one profession, in the pilot with eight schools, a new kind of project was developed. Common was the multidisciplinary project approach. This approach was new for all teachers and students**.** All teachers provided their students with a multidisciplinary challenge related to four to six disciplines, During the pilot, teachers discussed how to support multidisciplinary team work and a number of tools were presented by the researcher. The social cooperative Jigsaw method (Aronson, 2023; Slavin, 2015) and a Perspective-based Generic Questions Tool were applied in many projects.

In Jigsaw, illustrated in Figure 1, students combine working in project teams groups with working in expert groups. Students were initially placed in a project team to solve the problem or challenge posed by the client. The students then left the project teams to work in expert groups After they had become experts in the different disciplines related to the project, they returned to their project

teams to exchange information and use all the disciplinary perspectives to solve the problem or question at stake. This process requires students to explain their perspectives and integrate perspectives to create solutions. For example, in the project on meat substitutes students were divided into four expert groups, namely sociologists, food technologists, nutritionists and marketing experts. Each expert group had a meeting with an expert in "their " field, studied the problem together and then returned to their design team for joint problem solving and designing alternatives for meat. In traditional Jigsaw, students only explain the subject matter to each other, in our approach – which we could label Jigsaw 3 – they integrate knowledge into a design or advice for the client.

Fig 1.
Jigsaw 3 Approach in D&T projects based on Aronson, 2023.



The Perspective-based Generic Questions Tool is meant to scaffold teachers as well as students' questioning (De Boer, Janssen, van Driel, & Dam, 2021). The tool consists of cards for various disciplines each containing a series of general, domain-specific questions to inspire and support novices who have not yet highly detailed knowledge to come up with questions themselves. Many teachers in our study used the tool to develop their project and select questions, while other teachers gave the cards to their students to select relevant disciplines and questions for their project, providing the students more autonomy. See appendix A for an overview of the projects and conditions.

3.3. Intrinsic Motivation Inventory

The Intrinsic Motivation Inventory (IMI) (Center for Self-Determination Theory, 2023) was used to design a questionnaire. The IMI is a multidimensional instrument with 45 items on interest/enjoyment, perceived competence, effort, pressure, perceived choice, value/usefulness and relatedness that was adopted from earlier studies (McAuley, Duncan, & Tammen, 1987; Center for Self-Determination Theory, 2023). It specifically allows to assess intrinsic motivation during and after activities have been done.

IMI has been implemented in different contexts, including science education (Teppo et al., 2021), and Integrative STEAM programmes (Chiu, 2022; Jones, McDermott, Tyrer, & Zanker, 2018). The original items are generic and it is recommended that they are modified to suit the individual study.

The items were translated to Dutch and modified so that the items assess students perception of the multidisciplinary STEAM projects. Below is an example of a modified item:

Original item: ‘ I would describe this activity as very interesting.’

Modified Item: ‘I thought this project was very interesting.’

Although IMI has been used in project-based learning contexts before (Liu et al., 2006), we could not find items for relatedness that matched our context of project-based work in which students interact with clients and professionals in various disciplines. The IMI items are geared towards traditional learning activities. Relatedness questions did not specify persons “I’d like a chance to interact with this person more often”. As relations to teammates and clients/experts will be different, both groups were mentioned in the questions:

“I’d really prefer not to interact with this client anymore”

“I’d like a change to interact with these teammates more often”

New items – inspired by the phrases used in the original IMI - were developed to gain insight on the use of multiple perspectives as thi**s** was an important element of this project (item 6, 9, 12, 24, 25, 31). An example is: “I did put a lot of energy in understanding other perspectives.”

These perspective-related items will not measure the latent construct of effort, etc. as a whole, but to shed light on how students experience the multidisciplinary aspect of the project.

All items were evaluated by two Technasium teachers and they helped to select the most relevant ones from the IMI and the newly developed ones, which led to a few changes. Furthermore, the teachers proposed items that look into the relation between aspects that foster motivation, see for example an item combining choice and relatedness: “I received confidence from others to perform my duties”. All statements were presented using a 5-point Likert scale (1 – strongly disagree, 2- disagree, 3- neutral, 4 – agree, 5- strongly agree). During administration, three items were added later, see table 1 for an overview.

4. RESULTS

4.1. Intrinsic motivation

Half way during the project, 156 secondary students filled in the mid-questionnaire and 136 filled in the post-questionnaire one or two weeks after the project, see Table 1. Of these 92 students filled in both questionnaires. Beforehand, we expected that students might experience the project different halfway the project, then after completing the project. A Paired T-Test using the results of the 92 students who filled in both questionnaires showed that only, four items led to significant differences (Table 2). The students experienced more pressure at the end of the project (item 13 and 14) and their perception on the value of the results (item 8 and 22) increased. This shows that these items – meant to capture competence and value – are influenced by the stage of the R&D process, however, all other items measuring perceived competence and value were not influenced by this stage. Although we do know from the teachers in this pilot and from literature (IDEO 2023; Chiu 2021) that motivation goes up and down during project-work, generally speaking, for these participants, an IMI questionnaire at the middle or at the end of the project, show similar outcomes. Table 3 shows results of all respondents for the mid- and post-questionnaire.

Table 2.
Paired T-test. Items with significant differences (p< 0.10) between mid- and post-questionnaire are shown, n=92.

Themes		**Statements**	Mid	Post	Difference	95% Conf. Interval		Sig*
			Mean	Mean		Low	High	
Perceived Competence	8	I am very satisfied with my performance in this project.	3.39	3.64	.25	-0.453	-0.047	0.016
Presssure	13	I was anxious/nervous while working on the project (R)	1.72	1.96	.24	-0.429	-0.049	0.014
	14	I was relaxed during the project	3.74	3.53	-.21	0.018	0.395	0.032
Choice	19	I did the activities in the project because I wanted to.	3.12	3.29	.17	-0.381	0.033	0.099
Value	22	Our result was useful for the client	3.15	3.42	.27	-0.487	-0.057	0.014

* Significance, 2-tailed

Table 3.
Mean values and standard deviations of the mid- and post-questionnaire.

Themes		**Statements**	Mid (n=149-156)		Post (n=133-136)	
			M	SD	M	SD
Interest	1	The Design & Research project was fun to do.	3.05	0.84	3.03	1.00
	2	I felt like time flew by when I was working on the project.	2.88	1.00	2.82	1.13
	3	I thought this project was very interesting.	2.87 (n=55)	1.12	3.05 (n=88)	1.00
	4	The project for this client was very interesting.	3.09 (n=55)	0.93	3.17 (n=88)	0.96
Perceived Compe-	5	I think I am pretty good at solving Design & Research problems	3.49	0.77	3.45	0.81
tence	6	I did well in my role as expert	3.33	0.75	3.42	0.79
	7	I think I contributed pretty well at this activity, compared to other students.	3.41	0.73	3.51	0.82
	8	I am very satisfied with my performance in this project.	3.38	0.73	3.58	0.83
	9	I am good in combining insights from different disciplines.	3.46	0.80	3.44	0.74
Effort	10	I did not put much energy in the R&D project (R).	2.32	0.83	2.38	0.92
	11	I have put a lot of effort in this project	3.74	0.77	3.76	0.84
	12	I did put a lot of energy in understanding other perspectives.	3.22	0.78	3.26	0.81
Pressure	13	I was anxious/nervous during the project (R)	1.76	0.79	2.00	0.79
	14	I was relaxed during the project	3.69	0.74	3.56	0.88
	15	I felt pressured during the project (R)	2.33	0.88	2.51	1.06
	16	I was relaxed while conducting the project	3.62	0.85	3.57	0.80
Choice	17	I had a lot of freedom and could make my own choices during the project.	3.58	0.84	3.60	0.89
	18	There were so many possibilities in the project that I found it difficult to get started	2.68	0.89	2.66	0.96
	19	I did the activities in the project because I wanted to.	3.11	0.88	3.27	0.94
	20	I did not have a lot of choice in the way I did things for the R&D project.	2.79	0.86	2.64	0.79
Value	21	I think that doing this activity is valuable for society	3.06	1.01	3.11	1.04
	22	Our result was useful for the client	3.12	0.74	3.46	0.93
	23	I believe that conducting R&D projects is valuable for my future.	3.35	0.99	3.19	1.17
Value	24	I believe that learning to work with different perspectives is useful	3.76	0.78	3.69	0.80
	25	I experienced it as valuable to work from different profiles/expertise's	3.28	0.89	3.37	0.83

Themes		Statements	Mid (n=149-156)		Post (n=133-136)	
			M	SD	M	SD
Related-ness	26	I felt at ease with my teammates	4.02	0.81	3.83	0.86
	27	I'd like a chance to interact more often with these teammates	3.58	0.94	3.43	1.02
	28	I'd really prefer not to interact with this client in the future. (R)	2.86	0.97	2.98	1.00
	29	I had a strong bond with the client	2.21	0.89	2.20	0.89
	30	The experts were very approachable.	2.54 (n=24)	1.06	3.27 (n=63)	1.00
Combined themes	31	I found it difficult to consult with students who think differently from me.	2.16	0.85	2.21	0.90
	32	I received confidence from others to perform my duties.	3.53	0.75	3.45	0.76
	33	My team values my contribution.	3.64	0.82	3.64	0.88

We will now describe the results of the mid-questionnaire only. The intrinsic motivation of the students is on average just above the middle. Approximately 3 out of 10 pupils experience the project as fun and think it is interesting to work for the client. Most students feel competent, on average these items score 3.4. Almost nobody feels incompetent, however, students frequently select the neutral position. The average score for the Effort-items is 3.5 (when reversing the negatively posed item 10), this is higher than their interest-scores. This might indicate that there are external reasons to work on the project.

Students felt in general relaxed, although as indicated before felt a little more pressure at the end of the project. Students did experience choice, this is especially clear from item 17, "I had a lot of freedom and could make my own choices during the project". On the value-items, the average score is 3.3. Almost half of the participants (46%) beliefs that doing an R&D project is valuable for their own future. Learning to work with different perspectives has the highest score.

In general, students felt close to their teammates, see items 26, 27, 32, 33. They received confidence from others to perform their duties and that their team valued their contribution.

The experienced relatedness with clients and experts is less high at first sight. However, the correlation-matrix R showed that items 28 and 29 did not correlate well. A positive response on preferring not to interact with this client in the future does not necessarily mean an low relatedness with the client, it may also indicate that students prefer to do their next project around a new theme. Statement 29 on bonding with the client is probably too strongly posed. Secondary students will not view their relationship with clients in these terms, even when relationships are good. Other items of the original IMI (e.g. could become friends) were also not suitable to measure relatedness. Therefore, we added the statement "The experts were very approachable" later on. Further research on statements to measure relatedness in the context of client-based projects is recommended.

Students thought the project relevant, the score "Our results was useful for the client" significantly increased at the end of the project. They especially thought that learning to work with different perspectives was useful. They thus valued the newly developed multidisciplinary project approach using Jigsaw and other ways of combining different disciplinary perspectives.

Independent T-tests on all items were conducted to compare different groups. Comparisons where made based on study profile, R&D students versus non R&D students, grade and gender. Girls and boys enjoyed the project similarly and felt among teammates almost the same relatedness and interest in the project. A few significant differences were noted, see table 4 on the next page. Only those on pressure were consistently present in both questionnaires. Girls may have perceived a greater value and usefulness of the multidisciplinary projects. No significant differences between the two Nature profiles and the Economic and Society profile were found. The Dutch integrated multidisciplinary STEM projects thus accommodates all types of students. Students in the non R&D track thought the project more fun to do, but these results are not very reliable as these non-R&D track students are from two specific classes and the results could also be attributed to the specific project, client or teacher. Independent T-tests showed that grade 9 scored significantly lower on most of the motivational items (or higher for the reversed formulated ones). Grade 10 and 11 students are more motivated, this could be because after grade 9, students can decide to continue or quit the R&D track, so the more motivated students carry on. More results will be presented at the PATT conference.

Table 4.
Only items with significance ($p < 0.05$) gender differences are shown. Mean values of the mid- and post-questionnaire.

Themes		**Statements**	Mid (105 boys, 45 girls)		Post (96 boys, 35 girls)	
			Mean boys	Mean girls	Mean boys	Mean girls
Competence	6	I did well in my role as expert	3.39	3.16		
Effort	10	I did not put much energy in the R&D project (R).	2.45	2.04	2.52	1.89
Presssure	14	I was relaxed during the project	3.81	3.39	3.65	3.31
	16	I was relaxed while conducting the project	3.76	3.33	3.66	3.35
Value	21	I think that doing this activity is valuable for society	2.97	3.36		
	23	I believe that conducting R&D projects is valuable for my future.			3.03	3.63
Combined	25	I experienced it as valuable to work from different profiles/expertise's	3.17	3.56		
Relatedness	28	I'd really prefer not to interact with this client in the future. (R)	2.99	2.51		

4.2. Correlations, factor analysis and quality of the items

McAuley et al. (1989) examined the validity of the IMI and found strong support for its validity, both for a single and multiple factor model. However, this was in the context of sports education and items for relatedness and value were not yet present. As we developed new items, an analysis of the R-matrix and exploratory factor analysis was conducted on all items with more than 130 responses.

The R-matrix shows that the interest-items 1 and 2 correlate with each other (0.54). The interest-items also correlate rather strong with effort. So, interest raises effort and/or vice versa. The interest items also correlate with many of the value-items, the strongest correlation is with *"I believe that conducting R&D projects is valuable for my future*". This confirms that value is related to intrinsic motivation.

The competence-items correlate which each other, but just above the threshold of 0.30, so they either measure different aspects of competence or measure different constructs. The competence items also correlate with items 32 and 33. These two items are part of the set that measure variables in a combined way, in this case how persons perceive how people who work closely with them value their competence. We conjecture from these results that relatedness is relevant in project-work and that the way your team values you and your work maybe stronger than in more traditional education. Further research is needed.

Choice and relatedness interactions are also essential ingredients of project work, and this is also reflected in the newly added item 32. Students should give and receive confidence to each other during an integrated STEAM project, the scores of 3.53 shows that this condition was usually met.

Value was measured in different ways. Items 21, 22 and 23 focus on different external reasons, but still correlate (all above 0.37). The two items relating to the specific multidisciplinary nature of the project (24, 25) correlate slightly (0.30 - 0.34). One could question if one should use items that measure only a part of the value-construct. However, the items show that the use of perspectives and expert roles made the learning activities relevant.

Currently we are still working on the factor analysis using oblique rotation (Direct Oblimin). The Kaiser-Meyer-Olkin measure verified the sampling adequacy for the analysis, KMO = 0.78. However, a clear meaningful factor pattern could not be derived even after omitting problematic items. Quite often, correlations between items of different themes were similar or even stronger than those within a theme. Correlations between items of different themes were also found by (Jones et al., 2018) in the context of Integrative STEAM projects. As the sample size is below 300 and work is in progress, no definitive conclusion can be drawn.

5. DISCUSSION

The Multidisciplinary STEAM projects did not lead to a high intrinsic motivation, even when the need of relatedness in a team was in general met, pressure was low and when students on average are positive about the relevance of the project. The rather low intrinsic motivation may be caused by the low relatedness to the clients. This cannot be derived from the items in the questionnaire, but the open questions at the end of the questionnaire seem to suggest this. In addition, other factors may play a role.

The multidisciplinary approach developed in the Technasium pilot – approaching a problem or question from different perspectives and disciplines – often through Jigsaw- was valued as relevant by many of the students. Students from grade 10 and 11 are more intrinsically motivated, than the younger learners in grade 9. Students who continue the D&T track opt more often for STEM studies (science and engineering) compared to students with a Nature-profile (Blume-Bos, Van der Veen, Boerman 2020).

Vossen et. al. (2018) focused on secondary Dutch Research & Design students as well, found similar scores for enjoyment and anxiety for research projects, but higher scores on relevance than we did. For design projects, enjoyment was higher. Students in the United Kingdom enjoy their technology projects more than our students did, however, it is difficult to explain this difference using self-determination theory as the factors pressure and competence were not very different from the students in our study. Students in Hongkong who followed an integrated STEM projects had a higher intrinsic motivation than the Dutch students especially when their teachers had learned to support choice, relatedness and competence (Chiu, 2021).

Further development of Integrated STEAM projects with clients is needed as well as studies that provide insight in specific teacher strategies and project features that cause enjoyment as well as fulfilment of basic needs.

IMI is a relevant instrument to measure intrinsic motivation and its related factors for integrated STEAM project work with clients, however, items for relatedness need to be developed. Items that combine elements from different factors, shed a new light on motivation of students and are insightful as they show how relatedness in a team may influence perceived choice and competence. More research is needed with improved items and a less diverse group of participants.

6. ACKNOWLEDGEMENT

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8. APPENDIX

Item A:
An overview of the projects and conditions

School	Grade	Theme	Disciplines	R&D track	Jigsaw	Perspectives prompts
1	9	Local Hydrogen Use	Selected by students	yes	yes	Used by Students
2	9	Meat Substitutes	Sociologist/psychologist Nutritionist Marketing Food technologist	yes	yes	Used by teacher
3	9	Repurpose Deserted School Buildings	Selected by students	no	yes	Used by teachers

4	9	Refurbish Conference Room	Technology Social ex Spatial arrangements	yes	yes	No
5	10	Repurposing agricultural buildings	Architect Installation technologist Circular builder Biodiversity specialist Spatial planner	yes	yes	Used by teacher
6	10	Attractive City for companies and living in a relatively sparsely populated province	Geographer Historian Economist Psychologist	no	Unknown	Used by students
8	11	Development of a Skating Rink for the Community	Urban Developer Architect Demographic & historical researcher Ethnographic & Lifestyle researcher	Yes	Different Expert groups	Used by students