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Tony Houghton, Zsolt Lavicza, Robert Weinhandl, Imam Fitri Rahmadi, Brigitta Békési, Yves Kreis

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Expectation shock in education: utilising industry SERVQUAL to enhance student perception of STEAM and STEAM careers

Tony Houghton*, Zsolt Lavicza, Robert Weinhandl, Imam Fitri Rahmadi and Brigitta Békési

Department of STEM Education,
Linz School of Education,
Johannes Kepler Universität Linz, Austria
Email: ajh249@gmail.com
Email: lavicza@gmail.com
Email: robert.weinhandl@gmail.com
Email: imamrahmadi@unpam.ac.id
Email: bekesibrigitta@hotmail.com
*Corresponding author

Yves Kreis

Department of Education and Social Work,
Institute for Teaching and Learning,
University of Luxembourg, Luxembourg
Email: yves.kreis@uni.lu

Abstract: In industry, an expectation shock occurs when a customer has a post-experience perception that greatly exceeds their prior expectations. In our study, the customers are students and teachers. An expectation shock might occur when, for example, a student 'just did not expect to find STEAM so interesting'. The objective of this research was to determine how expectation shock might be used in schools to enhance student perception of STEAM and STEAM careers. It was found that expectation shock in the form of Hothousing intensive, collaborative workshops can be used in schools to greatly enhance student perception of STEAM and STEAM careers and give them experience of industry practise valuable for their future careers. Educational practice should focus on enhancing student or teacher perception rather than stated importance. It is essential to examine perception post-experience versus prior expectation to identify benefits (or not) from the activity.

Keywords: STEAM; careers; perception; expectation.

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Biographical notes: Tony Houghton is Visiting Professor at the Department of STEM Education, Linz School of Education, Johannes Kepler Universität Linz Austria.

Zsolt Lavicza is Professor in STEAM education and GeoGebra at the Department of STEM Education, Linz School of Education, Johannes Kepler Universität Linz Austria.

Robert Weinhandl is STEAM Education Researcher at the Department of STEM Education, Linz School of Education, Johannes Kepler Universität Linz Austria.

Imam Fitri Rahmadi is STEAM Education Researcher at the Department of STEM Education, Linz School of Education, Johannes Kepler Universität Linz Austria.

Brigitta Békési is PhD Student and Teacher at the Department of STEM Education, Linz School of Education, Johannes Kepler Universität Linz Austria.

Yves Kreis is STEAM researcher and Lecturer at the Institute for Teaching & Learning, Department of Education and Social Work, University of Luxembourg, Luxembourg.

1 Introduction

Science, Technology, Engineering, Art and Math (STEAM) and STEAM careers are widely acknowledged to be vital to Europe, industry and employment (European Commission, 2018; Thibaut et al., 2018). For students to choose STEAM careers however, it is essential that they have a positive perception of both STEAM and STEAM careers (Salmi et al., 2021).

One way to encourage a high perception is expectation shock (Houghton, 2005). The term expectation shock refers to when a customer, student or teacher has an experience perception that greatly exceeds their prior expectation creating an enduring enhanced perception shift. The objective of this research is to determine whether and how expectation shock derived from its fellow industrial tool SERVQUAL (Parasuraman et al., 1991) customer service perception might be used in schools to enhance student perception of STEAM and STEAM careers in an enduring way.

The next section describes the SERVQUAL and expectation shock rationale and its application using three industry case studies involving the use of a quantitative and qualitative Likert type questionnaire based on customer responses on their post-experience perception and their prior expectation. The three brief industry case studies serve to underline the industry connection and relevance, particularly as successful STEAM students might work in this environment. The approach is then applied in three student education STEAM projects each using a Hothousing intensive workshop approach (Houghton et al., 2022).

2 SERVQUAL and expectation shock

The study of perception is widespread in industry using the SERVQUAL customer service tool which focuses on perception, rather than asking the customer how important something is. Perhaps counter intuitively, customers, students or teachers should NOT be asked in isolation ‘how important is fun?’, or ‘what are the three most important

requirements of STEAM?' but about their perception post-experience versus their prior expectation. The argument is as follows: it is common practice to establish customer and user requirements by asking questions such as 'how important is reliability?' On a 1 – low to 5 – high Likert scale, customers typically say 5 and so effort is directed at enhancing customer service to meet the 5 requirement. Yet, such enhancements may be impossible and/or too costly. Also, as we will see below, they might say 5 for importance, have an expectation only 3 but be delighted with a perception of 4. Kano [reported by Chen (1992)] describes the risk as: "blindly fulfilling customer requirements by focusing only on what customers say, and not what they think." In other words, it is necessary to go beyond what they say and focus on their thought processes. Thus, the focus of industry service development is on what customers are thinking and the SERVQUAL approach to this is to understand customer perception. The challenge is to identify opportunities to offer a customer experience perception which exceeds their prior expectation. If the perception shift (i.e., the difference between post perception and prior expectation) is large enough, its effect is enduring, in the words of one customer, an 'expectation shock' (Houghton, 2005) who was "surprised or even pleasantly shocked at an unexpectedly high level of service."

SERVQUAL has also been used widely to assess expectations and perceptions of students (Tehranineshat et al., 2022) and career guidance courses (Kononiuk and Gudanowska, 2022). Perception of a STEM informal learning summer school has also been studied (Roberts et al., 2018) although not using the SERVQUAL approach. Interestingly, in this study, the students' perception included a high appreciation of facilities not available to them back at school. This raises the question whether this then gave them a positive or (more likely?) a negative perception of STEM as they experience it in their school without those facilities. Indeed SERVQUAL tells us that you should NOT automatically strive to offer students spectacular and/or wizz-bang, high profile, celebrity, one-day stand-alone activities that may be counterproductive if they are too far removed from their everyday school STEAM experience.

2.1 Perception versus expectation questionnaire

To identify any changes in perception, we can ask students or teachers their expectation prior to the activity and their perception post-activity. We can ask questions of the format in Table 1.

Table 1 Question format

To what extent do you feel that STEAM is of interest to you?				
What did you expect?				
1	2	3	4	5
Very low	Low	Average	Quite high	Very high
What did you find?				
1	2	3	4	5
Very low	Low	Average	Quite high	Very high
Explain in a few words (optional):				

In STEAM education, we can ask questions relating to STEAM and STEAM careers such as “to what extent are you aware of different routes into technology careers other than university?” or “to what extent do you feel communication and collaboration skills are important in technological activities?” or “to what extent do you feel that team working skills are important in technological activities?”

For each variable, subjects are asked on a scale of 1: low 5: high: ‘what did you expect?’ (expectation) and ‘what did you find?’ (perception).

They are also invited to provide verbatim comments to expand on or support their scores. As will be seen later, the mutual support of quantitative and qualitative data is important, indeed the need to give a score has been found to fire thinking and encourage the flow of comments. The questionnaire and question format is intended to be generic so that results can be used to benchmark and compare across case studies. It can be quick to administer (120 seconds). Alternatively, a complementary approach is to use the questionnaire and/or questionnaire responses for a subsequent in-depth interview with the subject. It is of course possible to ask the same question, e.g., “to what extent do you feel that STEAM is of interest to you?” before and after the activity, but it has been found that subjects are more richly able to compare their before and after views having undertaken the activity. This is so according to Chavan et al. (2014) because students have vague expectations and limited prior experience of the service from which to shape their expectations. If of course, the student or teacher has expectations based on extensive prior experience, then it is reasonable to ask the question both before and after.

Scoring responses 1 to 5 makes it possible to establish shifts which if high enough suggest an expectation shock. It has not been possible to determine exactly what change constitutes an expectation shock, however the following cases suggest a shift of +0.7 and upwards, when accompanied by associated, surprised, or agreeably shocked comments referring to the variable.

Both individual and group results can be presented in a summary template of various formats including both scores and key verbatim comments which can be compared for mutual support. There are no suggested statistical bases for this, however, Nielsen (1994), Nielsen and Mack (1994), Nielsen (2001), Nielsen and Loranger (2006) in user interface design and product development states that small groups, even as small as five will give a useful evaluation covering 85% of issues. An iterative development approach makes improvements and repeat evaluation a very cost-effective way to enhance the product or service be it a product such as a mobile device or a service such as a workshop. This issue is elaborated on in the discussion section exploring what can reasonably be inferred from the given limited data.

2.2 Expectation shock quantitative and qualitative

In order to estimate the perception shift in quantitative terms together with associated qualitative comments, we will turn briefly to three industry case studies in order to illustrate its application and the potential of the same approach in both industry and education.

The first study examined the British Telecom eContactCentre-BTBroadband service ‘call-me’ button, in which customers using the online site could ask for an adviser to call them back (Houghton, 2005). In July 2003, customers were contacted and invited to take part in a customer satisfaction survey asking about their views on the importance of a number of variables, their expectation before using the service and their perception after

using the service. For responsiveness/speed their responses were importance (5), expectation (3) and perception (4.4). It will be noted that their perception was lower than the importance they attached to the variable yet the perception shift of 1.4 was accompanied comments such as: "surprised or even pleasantly shocked by the … immediacy of the 'call-me", surprised how quick, "saves wasting time … absolutely excellent" thus illustrating the primacy of perception versus expectation over importance. Explicit comparisons between prior expectation and post perception also included; *expected usual Telco service … surprised how quick phoned back, exceeded expectation*. Similarly, for reliability at 0.9, the customer responses included: *dealing with someone who knows what they are talking about, whom … extremely surprised*.

In 2003, the take up of early mobile phones, labelled at the time multimedia messaging service (MMS) phones including photo capability was slow. To explore why this might be, nine students aged between 20 and 30, male and female, were invited to undertake tasks using the phone (Houghton, 2005). The biggest perception versus expectation shift was in the user interface 0.9. Together with comments: *much easier to use than expected, expected it to be huge, and nowhere near as complicated as I thought it would be*. At the time of the study, students judged fun to be the least important variable, yet the phone was judged much more fun than expected with a perception versus expectation shift of 0.8 and comments: *MMS is fun and when these phones become cheaper, many people will demand them*, thus again demonstrating the primacy of perception versus expectation over importance.

Lest it be thought that customer perception studies will produce only a positive expectation shock, a later study (Houghton, 2005), this time on a 3G iPhone look-alike phone revealed: *disappointed … expected the latest thing … flimsy … lacked support … may have raise expectations … expected more* accompanied by a user interface perception versus expectation of –0.7, a negative expectation shock.

From the above data, we might suggest an expectation shock in Industry as a 0.7 or greater shift on a Likert scale when accompanied by comments expressing surprise or shock comparing pre and post-experiences.

3 Student education

Turning to student education, whereas in the above studies we focused on perception of variables such as reliability, usability and responsiveness, the focus is also on those variables which enhance student, or indeed teacher, perception of STEAM and STEAM careers. Three projects are described: Global Hothouse, ORBIT and KIKS.

The question variables are mostly education related to such as student confidence, fun, technology communication and collaboration skills. In the following case studies, the main focus is on identifying enhanced perception of STEAM and STEAM careers.

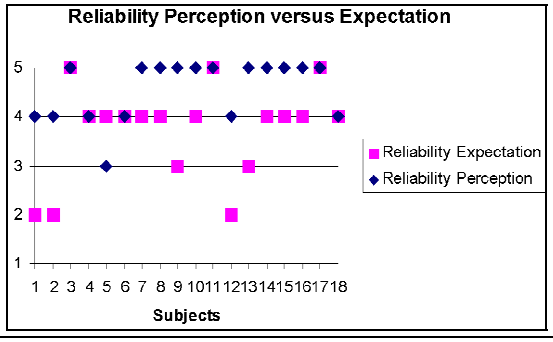
Responses can be collected and represented in various ways, depending on time availability and other factors (Table 2).

Table 2 Quantitative and qualitative data formats (see online version for colours)

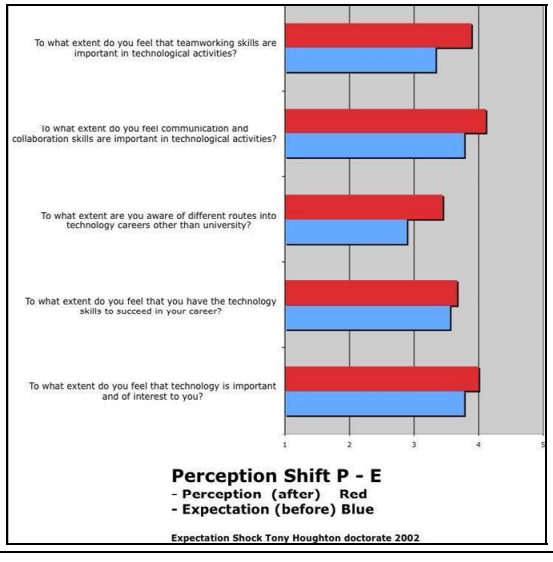
Tabular format

	Expectation	*Perception*	*Shift*
Confidence	3.7	4.6	0.9
Usability	3.7	4.4	0.7
Careers	3.8	4.3	0.5
Fun	3.8	4.6	0.8

Scatterplot



Graph (of individual or group)



Comments (as written or spoken)

"I didn't think I could do that."

"This is actually interesting."

"My expectations before I came here were that the technology would be unreliable and wouldn't be available until the distant future. But since I've seen everything the technology seemed reliable enough and wasn't too far away."

"I thought that new technology would be really hard to use but found it really simple."

3.1 Global Hothousing

The first Hothousing project (Houghton, 2005) was a mix of industry and education. Hothousing is British Telecoms's way of kick-starting IT products and services development. It puts customers and BT experts together in competing teams who work three 12-hour days to create and develop innovative, working prototype solutions. It is essentially an intensive collaborative problem solving process. The project described here is a variant of the adult approach and was a corporate social responsibility funded educational activity for 16 12–14 year old students. The purpose was twofold: to obtain a young customer perspective on future mobile devices and services and also to enhance their perception of BT as an employer and STEAM careers.

Each team of perhaps six people had a different idea to explore relating to different possible future mobile products such as intelligent driving, mobile wrist device, smart shopping trolley and mobile education. The students and BT experts worked three three-hour sessions over six months. The first session featured mobile technology teach-ins, followed by collaborative, creative group work culminating in a 60-second presentation of a possible concrete solution. The second and third sessions were less structured requiring that students led the activity and also made presentations, culminating in a working prototype demonstration.

3.2 ORBIT

At the Faculty of Education, University of Cambridge, 12 gifted students aged 15 years worked with GeoGebra mathematical modelling and simulation software to develop real life GeoGebra STEAM models for other less capable or interested students (Houghton et al., 2012).

The purpose was to enhance student perception of both STEAM and STEAM careers, and accordingly, the students were asked questions relating to technology importance, technology skills to succeed in their career, being aware of different routes into technology careers other than university, communication and collaboration skills and team working skills.

There were three two-hour sessions in which the students led their projects calling on GeoGebra experts as/if needed. As in the previous project, the first session focused on a technology teach-in in the form of a GeoGebra hands-on introduction, creative small group collaboration and 60-second presentation, with the second and third session increasingly led by students. The students presented their evolving model and ideas again culminating in a final working model.

Presentations with working models included paper plane origami design and flight, laws of gravity, football movement and planetary motion.

3.3 KIKS

Kid Inspiring Kids in STEAM (KIKS) is an EU Erasmus+ project with 400 14–16 year old students in twenty schools in four countries (Fenyvesi et al., 2017). The activity is described in Houghton et al. (2019): KIKS creativity and technology. Students were given the following challenge: "how would you get your schoolmates to love steam?"

A three-stage process featured a multi-school Hothousing workshop, followed by local challenges in which the schools developed their solutions and culminated in international collaboration in which students shared their work and worked together both physically in multi-school workshops and also online.

A wide number of projects were undertaken including robotics, merging visual art and music, and microbit control applications. An example of integrating various subject disciplines was an adaptation of the Rube Goldberg machine idea described in Wikipedia as: *a chain reaction-type machine or contraption intentionally designed to perform a simple task in an indirect and (impractically) overly complicated way. Usually, these machines consist of a series of simple unrelated devices; the action of each triggers the initiation of the next, eventually resulting in achieving a stated goal*. In the KIKS version, a chemical reaction released a toy car down a ramp, which was detected by another car which continued a journey avoiding a number of obstacles to knock off a row of books, which in turn hit a buzzer which provoked a final chemical reaction. A number of subjects were therefore engaged.

In some projects, both societal and technological challenges were addressed. In one project, the focus was on future city challenges and the concept of driverless cars was examined, including by building a traffic circuit with traffic lights and car control with sensors.

4 Results

The Global Hothousing project examined "young customers' perception of communications technology and the BT organisation with a view to encouraging students to consider BT and STEAM for their future careers." They were asked questions relating to reliability, usability, social interaction and fun. It will be seen that the highest shift of 0.9 in product/service reliability was accompanied by "my expectations before I came here were that the technology would be unreliable and wouldn't be available until the distant future. But since I've seen everything the technology seemed reliable enough and wasn't too far away." Similarly, the usability perception shift of 0.7 is accompanied by "I thought that new technology would be really hard to use but everyone found it really simple." In the same way, the perceptions of BT reflected change before and after, for example: "perception has changed and now consider BT a forerunner in future technology."

Overall, the data suggested a strongly enhanced perception of technology/STEAM and also BT, hopefully as a career choice. It is also possible to examine and compare the scores of individual students. This might be particularly valuable if there is a mix of technology enthusiastic and technology reluctant students, as we will see in the next case. The scatter plots in Figure 1 show the expectation and perception of individual students. For reliability, it can be seen that perception equalled or exceeded expectation in all but one case (subject 5).

For usability, it can be seen in Figure 2 that perception equalled or exceeded expectation in all but two cases (subjects 1 and 2). The qualitative comment associated with a particularly low score given by subject in which perception was 2 and expectation 4 goes some way to explain this: "I like 'hard to use' technology which is not very straightforward, as 'challenging to use' things are more interesting."

Table 3 Expectation and perception of BT and communications technology

Dimensions	*Expectation*	*Perception*	*Shift*
Reliability	3.7	4.6	0.9
Usability	3.7	4.4	0.7
Social	3.8	4.3	0.5
Fun	3.8	4.6	0.8
		Reliability	
"My expectations before I came here were that the technology would be unreliable and wouldn't be available until the distant future. But since I've seen everything the technology seemed reliable enough and wasn't too far away."			
		Usability	
"I thought that new technology would be really hard to use but everyone found it really simple."			
		Perception of BT	
"Perception has changed and now consider BT a forerunner in future technology."			
"Much wider customers: didn't realise they dealt with hospitals and banks."			
"Previously I only linked BT with phone and Internet services. I now am much more aware of their wider services and products."			
"I thought they just did telephones and Internet but they do a lot more."			

Figure 1 Reliability perception versus expectation (see online version for colours)

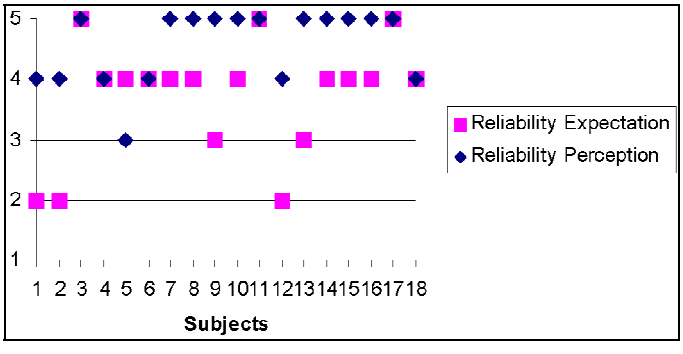
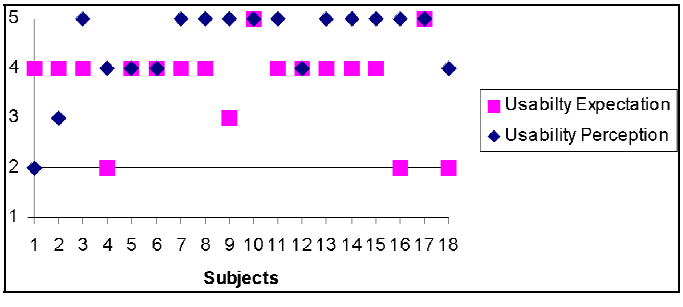


Figure 2 Usability perception versus expectation (see online version for colours)



In the ORBIT and KIKS projects, the questions were determined by the educational requirements of the project. For ORBIT, their answers (before, after and the shift or change) can be seen in Table 4 and Figure 3.

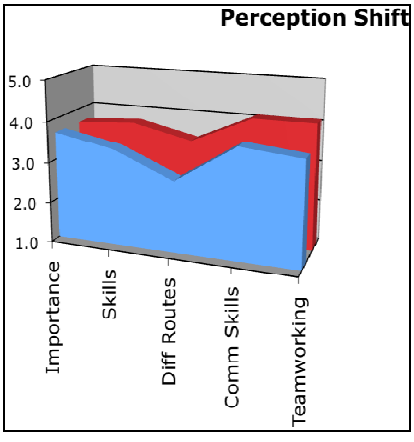
Table 4 ORBIT data

Dimensions	*Expectation*	*Perception*	*Shift*
Importance	3.7	3.7	0.0
Tech skills	3.4	3.8	0.4
Diff. routes to careers	2.8	3.4	0.7
Comm. skills	3.7	4.1	0.4
Team working	3.6	4.1	0.5
Careers			
Great opportunity to see the vast variety of careers and jobs available in STEM.			
A chance to see technology and resources not available in school and get expert tuition.			
Team working			
It has been good … great … teamwork important.			
I found asking others very helpful, as they share ideas with me, which I would not have previously thought of.			
This project has allowed me to create and present my ideas to other.			
Sharing ideas was very helpful in generating concepts for my project.			
I enjoyed the independence of the project and introduced us to each other to ensure we were comfortable with each other.			
Comm. skills			
How to present it in a way suitable for young people to use and interact with.			
General			
Thanks a lot, I've learnt a lot today!			
Fantastic experience, great software enjoyed the day.			
Really enjoyable day. A lot easier after getting to know the software.			
Cheers – enjoyed the day even though it was tough.			
Awesome experience, very nice software to work with thanks!			
Tough to start with but got progressively more enjoyable.			
Very enjoyable and challenging.			

It will be noted that the perception shifts, although very positive, are somewhat lower than the previous Global Hothousing study and the comments, although positive, it is nevertheless more difficult to find terms suggesting an expectation shock. By possible way of explanation, approximately 75% of students were already self-declared technology enthusiastic before undertaking the activity and so their perception shifts might be lower. Nevertheless, shifts could be detected in:

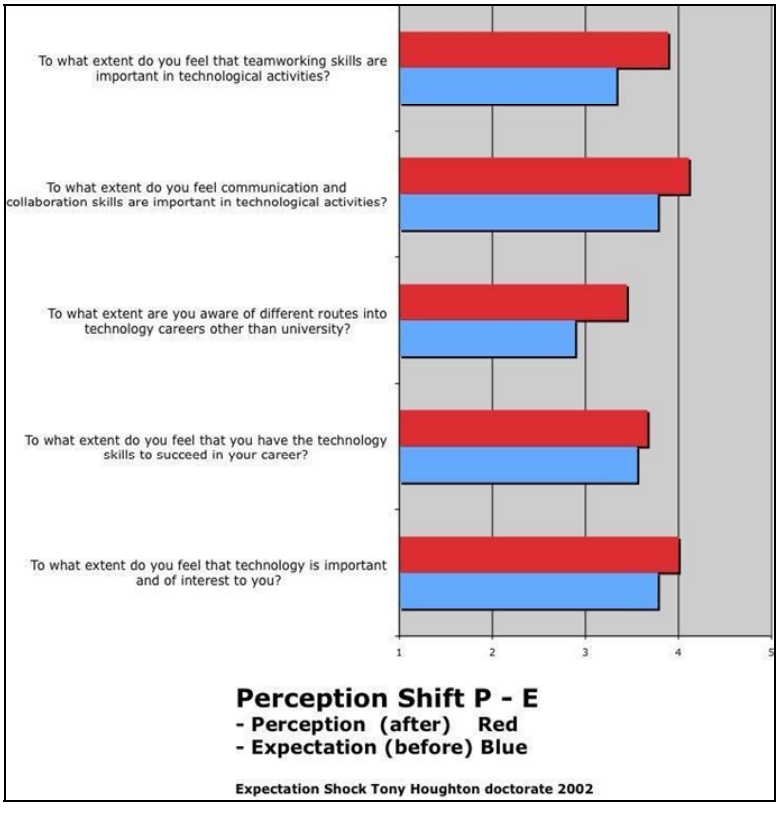
- awareness of routes other than university to a technology career
- awareness of the need for team working and communication skills.

Figure 3 ORBIT graphical data presentation (see online version for colours)



In contrast, enhanced perception of technology may also have occurred in a majority of those 25% who may fear, dislike or avoid technology.

Figure 4 Individual or group profile (see online version for colours)



The graphical, complementary presentation of the data allows us to easily visually compare different groups or sessions: (the expectation before is in blue and the perception after in red).

The KIKS project used the same questions and also a different format which allows us to either examine a group profile or individual. Individual graphs and comments can be enlightening, as in the case of the comment of a student who tells us that he 'knows most of it already'. Assuming this is true, this illustrates the need to offer a more challenging or otherwise enhanced experience.

5 Discussion

Three industry and three student education case studies have explored the difference between perception post-experience and prior expectation using a quantitative and qualitative questionnaire. Results confirm the importance of enhanced perception of both STEAM and STEAM careers as recommended by Salmi et al. (2021) and the importance of examining shifts or changes in perception pre- and post-experience, in contrast to the absence of before/after comparisons of student perception in the study by Roberts et al. (2018).

Because the questionnaire is used across a variety of cases, a number of ways to assess its validity and reliability were available. The Chartered Institute of Marketing defines validity as "does it actually measure what it purports to?" and reliability as "does it consistently measure the same thing?" It also states that: "good questionnaires are both reliable and valid. Repeat testing of questionnaires, and comparison with other data sources, are methods used to check both validity and reliability."

This repeat and comparison was achieved in a number of ways over the five diverse projects. The two industry eContactCentre and mobile phones studies suggested an expectation shock in industry as a 0.7 or greater shift on a Likert scale when accompanied by expectation shock comments expressing surprise or shock comparing pre- and post-experiences such as: *I just was not expecting that!* Or *before I was expecting ... but now ...* the education studies reported similar findings. The Global Hothousing study perception shift in reliability was +0.9 with *my expectations before I came here were that the technology would be unreliable and would not be available until the distant future. But since I have seen everything ...* the usability perception shift was +0.7 accompanied by before- and after-surprise: "I thought that new technology would be really hard to use but everyone found it really simple." The ORBIT study variable careers also had +0.7 with very positive comments as seen in the numbers and comments combined: "great opportunity to see the vast variety of careers and jobs available in STEM." The teamwork variable scored 0.4 with very positive comments which nevertheless do not exhibit an element of shock or surprise: "it has been good … great … teamwork important, I found asking others very helpful." Perhaps the scores were deflated because 75% of students already had a high perception. Negative expectation shocks can also be identified. For example, in the 3G phone case study, the tangibles score of –1.1 is accompanied by: *disappointed ... expected the latest thing ... flimsy ... lacked support ... may have raised expectations ... expected more*.

In summary, the five studies together suggested an expectation shock with a 0.7 or greater shift on a Likert scale when accompanied by expectation shock comments

expressing surprise or shock comparing pre- and post-experiences such as: I *just was not expecting that!* Or *before I was expecting ... but now ...*

Turning to the issue of what can be reasonably inferred from the relatively small number of subjects, Nielsen, as described earlier, stated that groups as small as five can give valuable data which cover 85% of issues and that iterative development and testing for improvement can improve on this in a cost-effective way. The findings of this study support this, in particular with the complementary quantitative and qualitative data.

A brief examination of other projects illustrates how the expectation shock might be applied.

The EU STEAMTEACH project (https://www.steamteach.unican.es/) is to develop a STEAM professional development project for teachers. A requirements-capture-exercise with teacher trainers determined that, in this case, for Austrian teachers, requirements included working in multidisciplinary groups, using project-based learning and also the affective factor is essential for students and teachers.

Workshops are undertaken with teachers based on the above. Thus, after the workshop, teachers can be asked questions like to what extent do you feel it is beneficial to work collaboratively in STEAM activities? To what extent do you find a project-based approach useful in STEAM activities? Also, by asking for each question, the two sub questions "what did you feel before this activity?" and "what do you feel now?" it is possible to establish any perception shifts: experienced, confident teachers may report little change whereas those less confident or versed in STEAM may (hopefully) report a greater change, even an expectation shock when they find "I didn't realise I could do that …"

The EU project STEAMConnect (https://steamconnect.education), as its name suggests, connects teachers, parents, artists, education experts and researchers from different disciplines to develop innovative transdisciplinary workshops and pedagogies. Thus, these various collaborators can be asked questions such as "to what extent do you feel that there is effective teacher collaboration in school on STEAM activities?" or "to what extent do you feel confident with STEAM activities?" or "to what extent do you feel that tracker (a movement analysis tool) supports collaborative problem-solving?"

The EU call Girls4STEM (https://www.euro-access.eu/calls/girls4stem) states that factors impeding girls' interest and involvement in STEM include: (low) self-perception, the perception of STEM professions and gender stereotyping embedded in the socialisation process. It reports that "girls have lower self-efficacy ratings in STEM, despite outperforming boys across school subjects." Even in one of the most gender-neutral countries in the world and despite the evidence of their own marks, "girls still seem to be succumbing to the stereotype that girls aren't as capable as boys." Accordingly, we can design STEAM activities where we can ask girls (and perhaps compare with boy responses) "to what extent do you feel confident with STEAM activities?" and "to what extent might you consider a career in STEAM?"

6 Conclusions

In summary we can conclude that variants of industry practice expectation shock and Hothousing can be used in schools to enhance student perception of STEAM and STEAM careers and give them an experience of industry practise valuable for their future

careers. Concerning educational practice it is essential that educational studies, projects and/or workshops focus on enhancing student perception whilst engaging in STEAM activities, reflecting the primacy of perception versus expectation over importance.

The expectation shock approach is a vehicle for iterative improvement: we need to understand student or teacher expectation as best we can prior to the workshop or other activity, in order to consider ways to enhance their perception. A first workshop or activity will clearly be based on best starting point estimates using teacher and student existing expertise and perceived knowledge of students. The quantitative and qualitative responses of students or teachers can then guide further refinement and development of projects and workshops. Any Hothousing workshop, project or activity with students should be carefully chosen to pitch it at the right level to invoke a positive reaction but not one where the experience is too far removed from, and hence not relatable to, the everyday school experience. Equally, we hope that we do not waste their time – if they are a bright STEAM-aware student already, or if they are a competent STEAM teacher, we should focus on activities that extend their competencies further and promote a perception shift. In contrast, with less confident subjects and teachers we may identify a relatively simple activity which nevertheless enhances their perception of STEAM and their own confidence.

References

Chavan, M., Bowden-Everson, J., Lundmark, E. and Zwar, J. (2014) 'Exploring the drivers of service quality perceptions in the tertiary education sector: comparing domestic Australian and international Asian students', *Journal of International Education in Business*, Vol. 7, No. 2, pp.150–180 [online] https://doi.org/10.1108/JIEB-02-2014-0004.

Chen, E. (1992) *Understanding Customer Requirements: Development of Metrics 1992, Kano [reported by Chen (1992)]* [online] http://www.servqual.com/kano.html.

European Commission (2018) *Council Recommendation of 22 May 2018 on Key Competences for Lifelong Learning (Text with EEA Relevance)* [online] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32018H0604(01).

Fenyvesi, K., Houghton, T., Diego-Mantecón, J., Crilly, E., Oldknow, A., Lavicza, Z. and Blanco, T. (2017) 'Kids inspire kids for STEAM', *STEAM*, Vol. 3, No. 1, pp.1–9 [online] https://doi.org/10.5642/steam.20170301.21.

Houghton, T. (2005) *Understanding Customer Behaviour to Enhance Telecommunications Networks and Services Design*, Doctoral thesis, University College London.

Houghton, T. and Oldknow, A. (2012) *GeoGebra STEM Exploration* [online] http://orbit.educ.cam.ac.uk/wiki/GeoGebraSTEM_exploration_day.

Houghton, T., Lavicza, Z., Diego-Mantecón, J.M., Fenyvesi, K. and Weirnhandl, R.I.F. (2022) 'Hothousing: utilising industry collaborative problem-solving practices for STEAM in schools', *Journal of Technology and Science Education*, Vol. 12, No. 1, pp.274–289.

Houghton, T., Oldknow, A., Diego-Mantecón, J.M., Fenyvesi, K., Crilly, E. and Lavicza, Z. (2019) 'KIKS creativity and technology for all', *Open Education Studies*, Vol. 1, No. 1, pp.198–208 [online] https://doi.org/10.1515/edu-2019-0014.

Kononiuk, A. and Gudanowska, A.E. (2022) 'The application of the customized SERVQUAL model for career guidance training: Industry 4.0 challenges', *Journal of Business Economics and Management*, pp.1–20 [online] https://doi.org/10.3846/jbem.2022.16643.

Nielsen, J. (2000) *Designing Web Usability*, New Riders, Indianapolis, IN.

Nielsen, J. (2001) *E-Commerce User Experience*, Nielsen Norman Group [online] https://www.nngroup.com/reports/ecommerce-user-experience/.

Nielsen, J. and Loranger, H. (2006) *Prioritizing Web Usability*, New Riders, Indianapolis, IN.

Nielsen, J. and Mack, R.L. (1994) *Usability Inspection Methods*, Wiley, New York, NY.

Parasuraman, A. (2000) 'The SERVQUAL model: its evolution and current status', *ARL's Symposium on Measuring Service Quality, Anais …*, ARL, Washington, pp.20–21.

Parasuraman, A., Berry, L.L. and Zeithaml, V.A. (1991) 'Understanding customer expectations of service', *Sloan Management Review*, Vol. 32, No. 3, pp.39–48.

Roberts, T., Jackson, C., Mohr-Schroeder, M.J., Bush, S.B., Maiorca, C., Cavalcanti, M., Craig Schroeder, D., Delaney, A., Putnam, L. and Cremeans, C. (2018) 'Students' perceptions of STEM learning after participating in a summer informal learning experience', *International Journal of STEM Education*, Vol. 5, No. 1, p.35 [online] https://doi.org/10.1186/s40594-018-0133-4.

Salmi, H., Thuneberg, H., Bogner, F.X. and Fenyvesi, K. (2021) 'Individual creativity and career choices of pre-teens in the context of a math-art learning event', *Open Education Studies*, Vol. 3, No. 1, pp.147–156 [online] https://doi.org/10.1515/edu-2020-0147.

Teeroovengadum, V., Kamalanabhan, T.J. and Seebaluck, A.K. (2016) 'Measuring service quality in higher education: development of a hierarchical model (HESQUAL)', *Quality Assurance in Education*, Vol. 24, No. 2, pp.244–258 [online] https://doi.org/10.1108/QAE-06-2014-0028.

Tehranineshat, B., Naderi, Z., Momennasab, M. and Yektatalab, S. (2022) 'Assessing the expectations and perceptions of nursing students regarding the educational services in a school of nursing and midwifery based on the SERVQUAL and Kano models: a case study', *Hospital Topics*, Vol. 100, No. 1, pp.26–34 [online] https://doi.org/10.1080/00185868.2021.1913080.

Thibaut, L., Ceuppens, S., De Loof, H., De Meester, J., Goovaerts, L., Struyf, A., Boeve-de Pauw, J., Dehaene, W., Deprez, J., De Cock, M., Hellinckx, L., Knipprath, H., Langie, G., Struyven, K., Van de Velde, D., Van Petegem, P. and Depaepe, F. (2018) 'Integrated STEM education: a systematic review of instructional practices in secondary education', *European Journal of STEM Education*, Vol. 3, No. 1 [online] https://doi.org/10.20897/ejsteme/85525.