The Investigation of the Relationship Between Uncertainty Management and Socially Shared Regulation of Learning

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Abstract

This research aims to investigate to what extent primary school children show uncertainty management and to what extent it affects their socially shared regulation behaviour during a collaborative task. During collaborative processes, uncertainties might arise. When these uncertainties are expressed more by the students this will result in higher-quality solutions, making it of essential importance during collaborative tasks. One thing that can be used when uncertainty arises and takes place during collaborative processes is SSRL. Considering that behaviours shown during uncertainty management also appear to be present in SSRL it would be interesting to investigate whether there appears to be a relationship between these variables. This relationship was tested by coding video recordings of primary school students performing a collaborative task. The outcomes of the coding process showed that primary school students were prone to engage in reduction strategies when faced with uncertainties. In addition, a correlational analysis showed that there appears to be a relationship between uncertainty management strategies and SSRL, as well as there appears to be a relationship between uncertainty management propensities and SSRL. Taken into account, that the interrater reliability of the coding scheme was lower than desired, future studies should determine whether the findings remain true without these limitations.

Introduction

Collaborative learning can be defined as two or more individuals working together on a joint task (Leeuwen & Janssen, 2019). Collaborative learning would, for example, include exchanging ideas, asking questions, and formulating solutions (Laal & Laal, 2012). Studies have shown that students who engage in collaborative learning achieve higher learning outcomes than their peers who work individually (Leeuwen & Janssen, 2019). In addition, Hogan & Young (2021) have demonstrated that collaborative learning has numerous academic benefits, for example, increased self-esteem and enhanced critical thinking skills. However, during a collaborative process, uncertainties often arise. These uncertainties might, for example, arise through dialogue when students self-explain or when inviting their peers to elaborate (Rodriguez et al., 2017). Uncertainty can be defined as “an individual’s subjective experience of doubting, being unsure, or wondering about how the future will unfold, what the present means, or how to interpret the past” (Jordan & McDaniel, 2014). Uncertainty does not only relate to the self, but instead, it can also refer to others or the environment.

Uncertainty should not only be seen as something negative, instead, it could also enhance the restructuring of current opinions, values, and conceptions (Jordan & McDaniel, 2014). Moreover, it creates possibilities for discussions, for knowledge construction, and helps to create explicit ideas (Chen, 2020). Furthermore, as mentioned by Jordan & McDaniel (2014) maintaining task uncertainty rather than instantly resolving it, is required for effective collaborative brainstorming. This might be because uncertainty can lead to curiosity and exploration of ways to resolve these uncertainties, allowing the students to learn (Rodriguez et al., 2017). This curiosity arises because humans prefer not to be in a state of uncertainty, as this state might give anxiety to the individual (Lieshout et al.,2021). Therefore, the curiosity reflects an urge to diminish uncertainty.

In addition to the stimulation of curiosity and exploration, the results of the research of Rodriguez et al. (2017) imply that the ways in which students who are working together express and address their uncertainty could have of high influence on their success during a learning activity. For example, groups who showed more expressions of uncertainty, e.g. by engaging in experimenting, created higher-quality solutions. Therefore, expressing and addressing uncertainties is of essential importance during collaborative tasks.

Another aspect that is necessary for collaboration to be successful is the regulation of task-related activities (Janssen et al.,2010). This can be done using socially shared regulation of learning (SSRL). SSRL will direct students to the adaptation of cooperative processes and enhances decision-making which stimulates learning (Rogat & Linnenbrink-Garcia, 2011).

As learning plays an important part in education it would be interesting to gain knowledge about which kind of uncertainty management strategies are used by students. However, the current understanding of how uncertainty is managed by learners is limited (Jordan & McDaniel, 2014). Therefore, it would be interesting to gain more insights into what uncertainty management behaviours are shown by students to enhance learning outcomes. In addition, considering that uncertainty management and SSRL are both of essential importance during collaborative tasks it might be interesting to investigate whether these variables are related. When finding a relationship, ways of enhancing either uncertainty management behaviour or SSRL can be identified to enhance learning outcomes.

Theoretical framework

Uncertainties in collaborative tasks are often difficult to manage and when uncertainties that are related to the confusion are not addressed successfully it can result in

frustration, and boredom (Rodriguez, 2017). However, individuals while working in groups are often eager to diminish uncertainties through several strategies (Jordan & McDaniel, 2014). In addition, the study by Jordan & McDaniel (2014) also showed that students heavily relied on reducing strategies to manage uncertainty. However, these strategies vary drastically between individuals (Dragnić-Cindrić et al., 2020). For example, uncertainty-oriented individuals are more likely to deal with uncertainty by engaging in active exploration and thinking deeply to resolve the uncertainty. However, opposingly, certainty-oriented individuals focus more on retaining clarity and try to avoid uncertainty by staying out of situations where uncertainties are created (Dragnić-Cindrić et al., 2020). Some strategies that are known to be used when facing uncertainties include increasing, maintaining, reducing, and ignoring (Jordan, 2015). The strategy 'Increase' includes opening the problem space, and purposefully seeking numerous alternative ways to resolve the uncertainty. Moreover, the strategy 'Maintain' involves acknowledging the uncertainty by, for example, generating new options, and talking about the shared understanding of the task. In addition, the strategy 'Reduce' includes attempting to resolve the uncertainty by, for example, explaining the problem to their peers. Furthermore, the strategy 'Ignore' would involve leaving the uncertainty unresolved by, for example, engaging in off-task behaviour and avoiding information.

In addition to the uncertainty management strategies, Jordan (2015) mentions another aspect of uncertainty management: propensities. Jordan (2015) describes propensities as dispositions towards uncertainty resulting from previous group participation and their social relations. Based on their research five propensities were defined: 1) Pause for reflection, 2) Seek a plausible explanation, 3) Request help, 4) Take action, and 5) Deny uncertainty. First, individuals who are labelled with the propensity 'Pause for reflection' tend to think before acting, mostly focusing on information present in sources outside of the group (e.g., texts). Second, the propensity 'Seek a plausible explanation' can be defined as individuals who are focused on fulfilling the task successfully. In addition, they frequently make use of peer support. Third, the propensity 'Request help' includes individuals who rely heavily on peer support. Fourth, contrarily, individuals displaying the propensity 'Take action' were prone to solve the uncertainty immediately (e.g., trial-and-error experimentation). Furthermore, when uncertainty arose in their groupmates, they often failed to acknowledge this. Lastly, the propensity 'Deny uncertainty' would include individuals who actively look for ways to avoid acknowledging the uncertainty. They would, for example, do this by claiming they know what

to do. If group members claimed to know the answer, they were eager to express that they already knew the solution the whole time.

As mentioned previously, uncertainties about a task allow space for discussion in collaborative tasks (Chen, 2020). One thing that can be used when uncertainty arises and that takes place during collaborative tasks is socially shared regulation. SSRL is a fairly new concept derived from self-regulation (Panadero & Järvelä, 2015). SSRL can be defined as "the social processes groups use to regulate their joint activity" (Vauras et al., 2003). It entails jointly regulating and modifying cognition, metacognition, behaviour, and motivation (Hogenkamp et al., 2021). Hogenkamp et al. showed that behaviours related to SSRL would, for example, include, task monitoring, task planning, problem-solving strategies, and positive social interactions. When students engage in SSRL it has been shown that they perceive the task as less difficult.

Taking the aspects of uncertainty management, strategies and propensities, numerous behaviours shown in SSRL can be found. For example, in the strategy 'Maintain' the student acknowledges the problem by, generating ways of how the problem might be resolved and talking about the shared understanding of the task. When looking at the behaviours shown in SSRL students might also talk about the shared understanding of the task by task monitoring, and generate options by task planning. Furthermore, it was mentioned by Jordan & McDaniel (2014) that by using the strategy 'Reduce' the students might explain the problem to others and will ask for ideas from others when they are curious about their input. In SSRL these behaviours are also shown by problem-solving strategies and positive social interactions (Hogenkamp et al., 2021).

As mentioned previously, only little research has been conducted about how uncertainties are managed by learners (Jordan & McDaniel, 2014). Therefore, this study aims to create an overview of what uncertainty management techniques are used by primary school children in the Netherlands. Furthermore, considering that uncertainty management and SSRL are both of essential importance to successfully fulfil collaborative tasks, the correlation between individuals' uncertainty management level and their level of socially shared regulation will be assessed. Hence, the research question is "To what extent do primary school children show uncertainty management and to what extent does it affect their socially shared regulation behaviour during a collaborative task?". Taking into account that it was mentioned by Jordan (2015) that in their study students heavily relied on reduction strategies, it is hypothesized that the uncertainty management strategy 'Reduce' will occur the most. In addition, it is hypothesized that the uncertainty management propensity 'Take action' will

occur most, as it focuses on reducing the uncertainty immediately. Furthermore, considering that behaviours shown in SSRL also appear to occur in uncertainty management behaviour, it is hypothesized that individuals who are high in their level of SSRL behaviour will also score high in uncertainty management.

Methods

Design and context

The data from a previously conducted study by van Dijk et al. (2019) was used to test the hypotheses. This research aimed to assess the cooperative dialogue between supported and unsupported groups. Therefore, the data of this study consisted of groups with support offered to structure the cooperative process and groups that worked without this support. For this research, only the groups of the unsupported condition were used.

During the study, the jigsaw method was used, where the students first worked together in a homogenous group where they had to gather knowledge about one topic (van Dijk et al., 2019). Here, the students learned about several topics, including, Light and heat, Oxygen, Water, and Nutrition. After the students had learned about their topic, they were substituted over heterogeneous groups including one student per topic. Here, the unsupported groups had to discuss the knowledge they gathered in the homogenous groups about their topics to, in the end, create a house on the moon where one should be able to live with four people. The work and process of the students in these heterogeneous groups were video and audio-recorded. With these recordings, it was assessed which uncertainty management behaviours these students showed and whether there was a relationship between uncertainty management and SSRL. This was done with the use of a coding scheme, where the conversation of the students was divided into segments, which were used as codes. For assessing the SSRL behaviour of the students the outcomes of the study of Hogenkamp et al. (2021) was used, whose study was also performed on the same data of van Dijk et al. (2019).

Participants

A sample of this study included 40 primary school students from six different primary schools in the Netherlands. The sample included fourth, fifth, and sixth-grade students. The gender distribution was 17 male (43,7%), 23 female (56,3%); M_{age}= 10,94 SD_{age}= .87

The primary school students worked together in heterogeneous groups of four people. These groups were created based on their ability level. Each group consisted of one high-ability student, two average-ability students, and one low-ability student.

Procedure

During the study, the students worked on the aforementioned task, creating a moon house where they would be able to live with four people, for one lesson. This lesson lasted for a maximum of 35 minutes, or when the students decided they were finished with the task

Data Analysis

To analyze the uncertainty management behaviours of the students, a coding scheme was created. This was done using the article of Jordan (2015). In this article, Jordan (2015) distinguished between two aspects of uncertainty, namely, strategies, and propensities.

Coding Scheme Strategies

Within strategies four subcategories were identified: ignore, reduce, increase, and maintain. Using these subcategories, specific behaviours were formed based on the descriptions mentioned in the article and used as codes as shown in Table 1.

Table 1.

Coding Scheme Uncertainty Management Strategies

	Concrete and observable behaviour Students…	Example
Ignore	…leaves the uncertainty unresolved by, for example, engaging in off-task behaviour and avoiding information.	
Exhibit off-task behaviour	… engages in off-task behaviour when other groupmembers are still working on the task	
Discounting negative information	…discredits the source …compares the current situation to a past instance of failed prediction	"Just leave it. Look this is the house"
Information avoidance/ignoring	…suppress currently held knowledge	"Yes that's what I thought"
Reduce	… attempts to resolve the uncertainty by, for example, explaining the problem to their peers	
Information gathering	…ask a teacher or groupmate for information	"But what topic did you have?"
Clarifying	…answer questions … clarify statements	"My topic was oxygen"
Solve inconsistency/weakness	… solves inconsistency that was brought up by another student	"No it can with a little spacesuit"
Explain the problem to others	… explains their train of thought or their ideas to others	"Okay, so we need at least something like a compressor"

Table 1. (Continued)

	Concrete and observable behaviour Students…	Example
Maintain	…acknowledges the uncertainty by, for example, generating new options, and talking about the shared understanding of the task	
Delaying decisions	… delays decisions	"Shall we maybe read this individually first"
Talk about the shared understanding	… talks about the shared understanding of the task	"The rest is about the moon house and we didn't hear anything about that"
Increase	… opens the problem space and purposefully seek numerous alternative ways to resolve the uncertainty	
Asking new questions	…ask new questions about the problem	"How much food and water would be necessary"
Share unclear parts of the problem	… point out parts of the problem that are not clear … shares what is not understood	"Then why are we even doing it"
Point out when something does not match with prior knowledge	… points out when something does not match with their prior knowledge	"Actually, that is not possible because than we would have to build a lot of spaceships"
Mention inconsistencies in arguments	… mentions weakness in the arguments of others	"That one cannot live there"

Coding Scheme Propensities

A similar approach, as was used for the strategies, was taken for creating the coding scheme for the propensities. According to Jordan (2015), several propensities can be identified in students, including, Seek plausible explanations, Pause for reflection, Request for help, Take action, and Deny uncertainty. Based on the quotes and descriptions stated in this article, the codes in Table 2 were created.

Table 2.

Coding Scheme Uncertainty Management Propensities

	Concrete and observable behaviour Students…	Example
Seek plausible explanations		
Seeking confirmation for potential actions	…presents an option to the group showing doubt or when curious to the opinion of others	"Maybe we should have fruit trees than"
Comparing multiple perspectives	… compares multiple perspectives to create plausible explanations observed and hypothesized outcomes	
Justifying	… justify next action to be taken	"We need a cow farm because then we can have milk and meat"
Mentioning inconsistencies	… Mentioning inconsistencies in ideas of others	"Those thin poles cannot keep up the entire house"
Collect more information	…Asks new questions to be able to resolve uncertainty themselves	"Pigs eat garbage right? Because then we can take those with us too"

Table 2. (Continued)

	Concrete and observable behaviour Students…	Example
Pause for reflection		
Delaying action in order to think	… actively stops group members to make decisions on the task to ensure understanding	"Could you slow down"
Reflect prior to proceeding	…reflects on the effect the decision has on the future	"But if the cows do that over and over again, then there is no water anymore"
Request for help		
Seeking assistance to resolve immediately presenting uncertainty	… request help to help solve the uncertainty	"Miss, what do we need to do"
Passing a task to someone else	… pass the task to another group member	"You need to tell us about your specialization first"
Take action		
Trial and error experimentation	… presents an option to the group without elaboration	"Maybe we need a towel"
Making a decision	… gives a demand of the next action that should be taken according to them without justification	"We also need a PS4"
Deny uncertainty		
Avoid acknowledging uncertainty	… expresses to group members that he/she knows what they need to do	"No that works"
Expressing great certainty that a bad outcome was imminent	… express to have predicted that a bad outcome was about to happen	"That is not going to work"

Coding Scheme SSRL

To analyze the SSRL behaviour of the students the coding scheme created by Hogenkamp et al. (2021) was used. In that study four subcategories of SSRL were identified, namely, Metacognition, Cognition, Behaviour, and Motivation (See Table 3).

Table 3.

Coding Scheme Socially Shared Regulation of Learning

	Concrete and observable behaviour Students…
Metacognition	
Task planning	…engage in goal setting …create a shared plan for the task
Task monitoring	…monitor their task progress (which parts of the task have already been performed and what still needs to be done) …monitor their task performance (how well the group is handling the task) …monitor comprehension (whether they understand the task or explanations given by others) …monitor task perceptions (whether they have shared attitudes towards the task)
Group planning	…coordinate their collaboration by dividing tasks etc.
Group monitoring	…monitor group performance
Task evaluation	…evaluate the task outcome

Table 3. (Continued)

	Concrete and observable behaviour Students…
Cognition	
Problem-solving strategies	…share learning strategies
Verifying	…discuss whether one's provided information is correct
Behaviour	
Positive social interactions	…involve group members in the group process when group members are curious about the input of others
Negative social interactions	…make negative comments about group members, bully or annoy them
Motivation	
Task motivation	…motivate other students to engage with the task …give positive remarks on the contribution of the group

As the study aims to identify the correlation between uncertainty management and SSRL, the video recordings were coded using ELAN to establish the frequencies in which the codes for uncertainty management strategies, uncertainty management propensities, and SSRL occurred. The data used for this study was already subdivided in segments based on students' speaking turns. When the student was interrupted, or a silence of more than two seconds occurred the segments were divided in two. In addition, when the students were talking off-topic to, for example, classmates, the researchers, or a silence occurred these segments were stated as non-codable and left out of the analysis. Using these segments, codes were given to each statement of a student.

To test inter-rater reliability five videos were coded by two researchers. These outcomes were used to compute Cohen's Kappa which resulted in a Kappa of *.30* for the

propensities and a Kappa of *.20* for the strategies. As these results were lower than desired, more strict rules were made and a hierarchy between subcodes was created. In these rules, it was discussed that for the uncertainty management strategies, the researcher should first decide which category would fit the segment, for example, ignore or reduce. Once this was done a code could be given to the segment. Furthermore, as the codes 'Clarifying' and 'Solve inconsistency' were overlapping it was agreed upon that whenever 'Mention inconsistencies' was used in one of the previous segments 'Solve inconsistency' was chosen over 'Clarifying'. When 'Mention inconsistencies' was not present in one of the previous segments 'Clarifying' was used when a student was reacting to an uncertainty of one of their peers. With these new rules the videos were coded a second time and a 20-minute video was coded by both research to assess whether the interrater reliability had improved. The outcomes of this showed a Cohen's Kappa of *.30* for the propensities and a Kappa of *.26* for the strategies.

Results

In this section, the quantitative data from the coding schemes is used to gain a better understanding about the relationship between uncertainty management and SSRL. First, descriptive statistics of the subcategories of uncertainty management strategies and propensities are reported. Second, the output of the correlational analysis is presented.

Descriptive statistics

This section presents to what extent uncertainty management strategies and its subcategories (Table 4) and uncertainty management propensities (Table 5) occurred. In addition, the frequencies of SSRL and its subcategories are visualized in Table 6.

Uncertainty management strategies

The data presented in Table 4 shows that the subcategory 'reduce' was shown the most and code 'generating or maintaining multiple options', which is part of the category 'maintain', was performed most by the participants.

Table 4

Outcomes Uncertainty Management Strategies

	Mean	SD	Min	Max	Total
Ignore	1.83	2.47	0	10	73
Exhibit off-task behaviour	1.58	2.15	0	8	63
Discounting negative information	0.08	0.27	0	1	3
Information ignoring	0.18	0.45	0	2	7
Maintain	4.80	5.33	0	20	184
Delaying decisions	0.08	0.35	0	2	3
Generating or maintaining multiple options	3.43	4.05	0	17	137
Talking about the shared understanding	1.30	2.82	0	17	52
Increase	2.65	3.17	0	16	91
Asking new questions	0.40	0.93	0	5	16
Mentioning inconsistencies in arguments	1.68	2.00	0	9	67
Sharing what is not understood	0.40	0.67	0	2	16
Pointing out when something does not match with prior knowledge	0.18	0.45	0	2	7

Table 4. (Continued)

	Mean	SD	Min	Max	Total
Reduce	8.28	8.16	0	39	284
Asking a teacher or groupmate for information	2.78	3.50	0	15	111
Answering or clarifying statements	1.93	2.00	0	9	77
Solve inconsistencies	0.90	1.32	0	6	36
Explaining the problem to others	2.68	4.72	0	26	107

Uncertainty management propensities

For the uncertainty management propensities, 'Seek plausible explanations' was shown the most (Table 5.). From the codes 'Justify next action to be taken', which is part of the subcategory 'Seek plausible explanations', was performed the most by the students, and 'Expressing great certainty that a bad outcome was imminent', which is part of the subcategory 'Deny uncertainty', was shown the least.

Table 5

Outcomes Uncertainty Management Propensities

	Mean	SD	Min	Max	Total
Seek plausible explanations	4.73	4.88	0	19	189
Justify next actions to be taken	2.00	3.27	0	8	80
Mention inconsistencies in ideas of others	1.33	1.29	0	1	53
Seeking confirmation for potential actions	0.63	1.23	0	2	25
Comparing multiple perspectives	0.13	0.33	0	20	5
Collect more information	0.65	0.92	0	2	26
Pause for reflection	1.05	1.63	0	17	42
Delaying action in order to think	0.13	0.33	0	17	5
Reflect prior to proceeding	0.93	1.56	0	16	37
Request for help	1.15	1.61	0	5	46
Seeking assistance to resolve uncertainty	1.03	1.54	0	9	41
Passing a task to someone else	0.13	0.40	0	2	5
Take action	3.75	3.04	0	2	150
Make a decision	1.98	2.56	0	39	79
Trial and error experimentation	1.78	1.72	0	15	71

Table 5 (Continued)

	Mean	SD	Min	Max	Total
Deny uncertainty	0.15	0.43	0	9	6
Expressing great certainty that a bad outcome was imminent	0.03	0.16	0	6	1
Avoid acknowledging uncertainty	0.13	0.33	0	26	5

SSRL

The outcomes of SSRL show that the category 'Metacognition' was performed the most by the students. Moreover, the category 'Motivation' was not performed by any of the students. In addition, to the frequency of the categories, the code 'Task planning' was performed most (Table 6).

Table 6.

Outcomes subcategories

	Mean	SD	Min	Max	Total
Metacognition	.55	1.06	0	4	22
Task planning	.18	.50	0	2	7
Task monitoring	.1	.38	0	2	4
Group monitoring	.13	.33	0	1	6
Group planning	.15	.48	0	2	5
Task evaluation	0	0	0	0	0
Cognition	.1	.30	0	1	4
Problem-solving strategies	0	0	0	0	0
Verifying	.1	.30	0	1	4
Behaviour	.13	.40	0	2	5
Positive social interactions	.1	.38	0	2	4
Negative social interactions	.03	.16	0	1	1
Motivation	0	0	0	0	0
Task motivation	0	0	0	0	0

Correlational analysis

In order to reject or retain the hypothesis 'Individuals who are high in their level of SSRL behaviour will also score high in uncertainty management', a correlational analysis was conducted between the sumscores of uncertainty management strategies and SSRL, together with a correlation analysis between the sumscores of uncertainty management propensities and SSRL.

Uncertainty Management Strategies

The outcomes of the correlational analysis between uncertainty management strategies and SSRL, presented in Table 7. The correlation between the subcategory motivation and uncertainty management could not be computed as this behaviour was not shown between the students. The outcomes of the correlation analysis show a relationship between Uncertainty Management Strategies and SSRL, as well as, a correlation between the subcategory Maintain

and SSRL, and the subcategory Reduce and SSRL. Furthermore, the correlation analysis showed a correlation between the subcategory Increase and the subcategory Metacognition.

Table 7

Spearman's Correlational Analysis Strategies and SSRL (N=40)

	Uncertainty management strategies	**Maintain**	**Reduce**	**Increase**	**Ignore**
SSRL	*.36 **	*.32**	*.37**	*.29*	*.24*
Metacognition	*.33*	*.26*	*.23*	*.42**	*.19*
Cognition	*.18*	*.29*	*.26*	*0*	*.17*
Behaviour	*.13*	*.06*	*.18*	*0*	*.14*

Note. * p< 0.05

Uncertainty Management Propensities

In Table 8. the result of the correlational analysis between uncertainty management strategies and SSRL are shown. The results of analysis show a correlation between uncertainty management propensities and SSRL. In addition, a correlation is found between the subcategory Pause for Reflection and SSRL, as well as, a correlation between Pause for Reflection and the subcategory Metacognition. Furthermore, a significant correlation was found between the subcategory Request for Help and the subcategory Cognition.

Table 8.

Spearman's Correlational Analysis Propensities and SSRL (N=40)

	Uncertainty management propensities	**Seek plausible explanations**	**Pause for reflection**	**Request for help**	**Take action**	**Deny uncertainty**
SSRL	*.37**	*.23*	*.44**	*.25*	*.30*	*.20*
Metacognition	*.24*	*.16*	*.43**	*.14*	*.17*	*.25*
Cognition	*.18*	*.04*	*.21*	*.37**	*.16*	*.12*
Behaviour	*.22*	*.14*	*.07*	*.06*	*.31*	*-.13*

Note. * p< 0.05

Discussion

This study aimed to assess to what extent primary school students show uncertainty management and to what extent their uncertainty management is related to SSRL. The outcomes showed that overall students use numerous different types of uncertainty management strategies and propensities. Focusing specifically on the uncertainty management strategies it was shown that the students showed the category 'Reduce' the most. These findings are in line with the hypothesis which expected that the uncertainty management strategy 'Reduce' would occur the most, and therefore the hypothesis can be retained. This implies that when facing uncertainties students are eager to diminish their uncertainty by coming up with possible solutions. This was also found in previous research by Jordan (2015) who stated that students relied heavily on reduction strategies. This might be because, as mentioned by Lieshout et al. (2021), uncertainty might create anxiety for the individual, creating an urge to diminish the uncertainty. However, the results also showed that students, during collaborative tasks, are prone to maintain uncertainty by generating multiple options that might help to resolve the uncertainty. This might be explained by Jordan (2014) who stated that the uncertainty management strategies used by students also rely heavily on the behaviour of peers. Therefore, not only codes falling under the category 'reduce' might be shown but codes falling under different categories might occur frequently as a result of the behaviour shown by peers.

For the uncertainty management propensities, 'Seek plausible explanations' was shown the most. These findings are against the hypothesis which expected that the propensity Take Action would occur the most, and therefore the hypothesis can be rejected. As mentioned by Jordan (2015) students displaying the propensity 'Seek plausible explanations' are also prone to focus on fulfilling the task successfully. These findings might therefore imply that during collaborative tasks students have the need to fulfil these tasks successfully by, for example, mentioning inconsistencies in the ideas of others, and collecting more information about the task. This outcome might have occurred because, as mentioned in Jordan (2015), the patterns of uncertainty management also relied heavily upon task characteristics. Therefore, it might have been that the task directed the students to behave in ways that were more related to the propensity Seek Plausible Explanations, as the task was to create a moon house for all four of the students input from all the students about their needs is required. This might explain why the propensity Take Action was used less than Seek Plausible explanations, since Take Action, for example, includes the behaviour Make a Decision which does not have to include a discussion with other group members, whereas,

Seek Plausible Explanation, includes of Seeking Confirmation for Potential actions, and Mention Inconsistencies in ideas of others, which is more directly related to group conversations.

Strategies

The outcomes of the correlational analysis between uncertainty management and SSRL showed that there appears to be a positive relationship between uncertainty management strategies and SSRL, meaning that individuals who are higher in showing uncertainty management strategies also show higher numbers of SSRL behaviours. When focusing on the subcategories of the uncertainty management strategies, both 'Maintain' and 'Reduce' have a positive relationship with SSRL. These findings are in line with the hypothesis which expected to find higher levels of uncertainty management in students who are also higher in their level of SSRL and vice versa. This outcome might be explained because the behaviours falling under the categories 'Maintain' and 'Reduce' are often performed by students who are actively working on resolving the uncertainty that arose during the joint activity. By actively working on resolving or regulating the joint activity the students might have to engage in SSRL behaviour, considering that SSRL also occurs when regulating the joint activity, which might explain the positive relationship between these variables (Vauras, et al., 2003). However, the lack of correlation between the subcategory Ignore and SSRL might be explained as this part of uncertainty management strategy is mostly about performing off-task behaviours. Considering that SSRL relates to the social process that are used to regulate their joint activity, and ignoring is most often performed by students who are not eager working or regulating the joint activity, it might therefore explain why no relationship between these two variables was found.

Propensities

The outcomes of Spearman's correlation analysis show that there is a positive relationship between uncertainty management propensities and SSRL. This implies that students who score higher on uncertainty management propensities will also show higher numbers of SSRL behaviour, and therefore, the hypothesis can be retained.

Furthermore, a positive relationship was found between the subcategory 'Pause for Reflection' and SSRL As mentioned previously, individuals labelled with the propensity 'Pause for Reflection' are mostly focused on information present in sources outside of the group and they tend to think before acting (Jordan, 2015). This relationship might be explained since one aspect of SSRL is monitoring performance and how the task is going. In other words, when monitoring the student pauses decision-making and actively thinks about

the progress and performance the group is making. Therefore, the student would thus exhibit the behaviour of thinking before acting. In addition, this might also explain the positive relationship between the subcategory Pause for Reflection and Metacognition, since almost all the behaviours falling under 'Metacognition' are related to either monitoring and evaluating. In addition, a positive relationship was found between the subcategory Request for Help and Cognition. Individuals with the propensity Request for Help rely heavily on peer support (Jordan, 2015). Considering that cognition includes of sharing learning strategies, and discussing whether one's provided information is correct the relationship might be explained. In the category cognition, the student would thus be eager to ask for validation of peers on their input.

Limitations

The first limitation of this study is the low inter-rater reliability of the coding schemes, resulting in less reliable outcomes. For the uncertainty management strategies most differences seemed to have occurred between codes of the same subcategory. For example, one researcher chose the code 'Explain the problem to others' from the subcategory 'Reduce', whereas, the other researcher chose 'Clarifying statements' from the same subcategory. This might imply that the results of the subcategories remain valid, however, the results for the specific codes might differ when the inter-rater reliability would have been higher. For the uncertainty management propensities most differences arrived because one researcher coded more segments as propensity than the other researcher. To solve this issue, stricter rules should be made to ensure all relevant codes will be coded by all researchers and in the right subcode. These rules, for example, include of first determining the subcategory the segment would belong to before placing it in a certain code.

Another limitation of the study is regarding the task, since the task might have directed the participants in showing certain behaviours. For example, the code 'Generating and maintaining multiple options' was shown the most by the participants, which might be because the task guided the participants to generate numerous options to arrive at a shared moon house with the needs of everyone. Therefore, the outcomes of future studies conducted on the same topic might show different results depending on the task that is chosen.

Practical implications

The outcomes of this study show a correlation between uncertainty management strategies and SSRL, as well as between uncertainty management propensities and SSRL. In addition, the study gives insight in which uncertainty management behaviours are shown by primary school students during collaborative processes. As this showed that primary school

students mainly used reduction uncertainty management strategies it might be important for teacher to take this into account when teaching. As the students try to reduce the uncertainty immediately it might be that they do not take enough time to carefully think about the topic, but instead, try to rush through the process in order the resolve the issue as fast as possible. Considering that it was mentioned by Jordan & McDaniel (2014) that it is often preferred to amplify uncertainty for students to let them rethink their current beliefs, it might therefore be important to ensure that students do not rush through the process but instead take the time for each uncertainty to rethink their beliefs.

Conclusion

To conclude, this research aimed to assess to what extent primary school students showed uncertainty management behaviour and to what extent uncertainty management was related to SSRL. The outcomes showed that primary school students mainly used reduction strategies and the 'Take Action' propensity. In addition, a positive relationship is found between uncertainty management and SSRL, meaning that individuals who are higher in uncertainty management are also more likely to engage in SSRL behaviours. Considering that uncertainties are frequently occurring in the educational context, the findings might be important to consider for teachers to ensure optimal learning outcomes.

Taking into account that the study has several limitations, future research should be conducted to ensure that the findings remain true when interrater reliability is sufficient.

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Appendix

Appendix A R Script

```
library("tidyverse")
library("foreign")
library("ggplot2")

library("janitor")

library(stats)

library("dplyr")

library(topicmodels)
moira<-Copy_of_Thesis_Outcomes_Coding_Strategies_Sheet1_2
#descriptive statistics

moira %>% summary()
moira %>% map(sd)

moira2<- Copy_of_Thesis_Outcome_Propensities_Sheet1
moira2 %>% summary()
moira2 %>% map(sd)
New_Copy_of_Thesis_Outcome_Transactivity_Sheet1 %>% map(sd)
#histogram normality
New_Copy_of_Thesis_Outcomes_Coding_Strategies_Sheet1%>%
  ggplot(aes(x = `Total strategies`)) +
  geom_histogram(binwidth = 1)
New_Copy_of_Thesis_Outcome_Propensities_Sheet1%>%
  ggplot(aes(x = `Total propensities`)) +
  geom_histogram(binwidth = 1)

New_Copy_of_Thesis_Outcome_Transactivity_Sheet1%>%
  ggplot(aes(x = Total)) +
```

```
  geom_histogram(binwidth = 1)
Moi_ra_Data_M7_Sheet1 %>%
  ggplot(aes(x = `Self-efficacy` + SSRL)) +
  geom_histogram(binwidth = 1)


#Kendall

library(Kendall)
Kendall(Thesis_Strategies_SSRL_Combination_Sheet1$`Total SSRL`,
Thesis_Strategies_SSRL_Combination_Sheet1$`Total strategies`)

library(Kendall)
Kendall(moira$`Total SSRL`, moira$Ignore)

library(Kendall)
Kendall(moira$`Total SSRL`, moira$Reduce)

library(Kendall)
Kendall(moira$`Total SSRL`, moira$Maintain)

library(Kendall)
Kendall(moira$`Total SSRL`, moira$Increase)

library(dplyr)

library(broom)

moira %>%map(sd)

corr <- cor.test(x= moira$`Total strategies`, y=moira$`Total SSRL`, method = 'spearman')
corr
corr1 <- cor.test(x= moira$Maintain, y=moira$`Total SSRL`, method = 'spearman')
corr1
```

```
corr2 <- cor.test(x= moira$Reduce, y=moira$`Total SSRL`, method = 'spearman')
corr2

corr3 <- cor.test(x= moira$Increase, y=moira$`Total SSRL`, method = 'spearman')
corr3

corr4 <- cor.test(x= moira$Ignore, y=moira$`Total SSRL`, method = 'spearman')
corr4



corr2 <- cor.test(x= moira$Maintain, y=moira$Metacognition, method = 'spearman')
corr2

corr3 <- cor.test(x= moira$Maintain, y=moira$Cognition, method = 'spearman')
corr3

corr4 <- cor.test(x= moira$Maintain, y=moira$Behaviour, method = 'spearman')
corr4
corr4 <- cor.test(x= Thesis_Strategies_SSRL_Combination_Sheet1_2$Ignore,
y=Thesis_Strategies_SSRL_Combination_Sheet1_2$Motivation, method = 'spearman')
corr4

corr4 <- cor.test(x= Thesis_SSRL_Propensities_Sheet1$`Total propensities`,
y=Thesis_SSRL_Propensities_Sheet1$`Total SSRL`, method = 'spearman')
corr4

corr4 <- cor.test(x= Thesis_SSRL_Propensities_Sheet1$`Seek plausible explanations`,
y=Thesis_SSRL_Propensities_Sheet1$`Total SSRL`, method = 'spearman')
corr4

corr4 <- cor.test(x= Thesis_SSRL_Propensities_Sheet1$`Pause for reflection`,
y=Thesis_SSRL_Propensities_Sheet1$`Total SSRL`, method = 'spearman')
corr4
```

```
corr4 <- cor.test(x= Thesis_SSRL_Propensities_Sheet1$`Request for help`,
y=Thesis_SSRL_Propensities_Sheet1$`Total SSRL`, method = 'spearman')
corr4

corr4 <- cor.test(x= Thesis_SSRL_Propensities_Sheet1$`Take action`,
y=Thesis_SSRL_Propensities_Sheet1$`Total SSRL`, method = 'spearman')
corr4

corr4 <- cor.test(x= Thesis_SSRL_Propensities_Sheet1$`Deny uncertainty`,
y=Thesis_SSRL_Propensities_Sheet1$`Total SSRL`, method = 'spearman')
corr4
cronbach.alpha(Overall_MW_xlsx_Werkblad_1_SSRL_Data_All_pa_4)

corr2 <- cor.test(x= moira$Reduce, y=moira$Metacognition, method = 'spearman')
corr2

corr3 <- cor.test(x= moira$Reduce, y=moira$Cognition, method = 'spearman')
corr3

corr4 <- cor.test(x= moira$Reduce, y=moira$Behaviour, method = 'spearman')
corr4

corr4 <- cor.test(x= moira$Ignore, y=moira$`Task planning`, method = 'spearman')
corr4

corr4 <- cor.test(x= moira$Ignore, y=moira$`Task monitoring`, method = 'spearman')
corr4

corr4 <- cor.test(x= moira$Ignore, y=moira$`Task evaluation`, method = 'spearman')
corr4

corr4 <- cor.test(x= moira$Ignore, y=moira$`Group planning`, method = 'spearman')
corr4
```

```
corr4 <- cor.test(x= moira$Ignore, y=moira$`Positive social interactions`, method =
'spearman')
corr4
moira<-Thesis_Outcome_SSRL_with_Ignore_Sheet1
library(ltm)

library(msm)
library(polycor)

moira<-Thesis_SSRL_Propensities_Sheet1

moira<-Thesis_Outcome_SSRL_Sheet1

moira<-Thesis_Strategies_SSRL_Combination_Sheet1_2

corr4 <- cor.test(x= moira$Increase, y=moira$Metacognition, method = 'spearman')
corr4

corr4 <- cor.test(x= moira$Increase, y=moira$Cognition, method = 'spearman')
corr4

corr4 <- cor.test(x= moira$Increase, y=moira$Behaviour, method = 'spearman')
corr4

corr4 <- cor.test(x= moira$Ignore, y=moira$Behaviour, method = 'spearman')
corr4

corr4 <- cor.test(x= moira$Ignore, y=moira$Cognition, method = 'spearman')
corr4

corr4 <- cor.test(x= moira$Ignore, y=moira$Metacognition, method = 'spearman')
corr4

corr4 <- cor.test(x= moira$`Total strategies`, y=moira$Metacognition, method = 'spearman')
```

```
corr4

corr4 <- cor.test(x= moira$`Total strategies`, y=moira$Cognition, method = 'spearman')
corr4

corr4 <- cor.test(x= moira$`Total strategies`, y=moira$Behaviour, method = 'spearman')
corr4

moira<-Thesis_SSRL_Propensities_Sheet1

corr4 <- cor.test(x= moira$`Total propensities`, y=moira$Metacognition, method =
'spearman')
corr4

corr4 <- cor.test(x= moira$`Total propensities`, y=moira$Cognition, method = 'spearman')
corr4

corr4 <- cor.test(x= moira$`Total propensities`, y=moira$Behaviour, method = 'spearman')
corr4

corr4 <- cor.test(x= moira$`Seek plausible explanations`, y=moira$Behaviour, method =
'spearman')
corr4

corr4 <- cor.test(x= moira$`Seek plausible explanations`, y=moira$Cognition, method =
'spearman')
corr4

corr4 <- cor.test(x= moira$`Seek plausible explanations`, y=moira$Metacognition, method =
'spearman')
corr4

corr4 <- cor.test(x= moira$`Pause for reflection`, y=moira$Metacognition, method =
'spearman')
```

```
corr4

corr4 <- cor.test(x= moira$`Pause for reflection`, y=moira$Cognition, method = 'spearman')
corr4

corr4 <- cor.test(x= moira$`Pause for reflection`, y=moira$Behaviour, method = 'spearman')
corr4

corr4 <- cor.test(x= moira$`Request for help`, y=moira$Behaviour, method = 'spearman')
corr4

corr4 <- cor.test(x= moira$`Request for help`, y=moira$Cognition, method = 'spearman')
corr4

corr4 <- cor.test(x= moira$`Request for help`, y=moira$Metacognition, method = 'spearman')
corr4

corr4 <- cor.test(x= moira$`Take action`, y=moira$Behaviour, method = 'spearman')
corr4

corr4 <- cor.test(x= moira$`Take action`, y=moira$Cognition, method = 'spearman')
corr4

corr4 <- cor.test(x= moira$`Take action`, y=moira$Metacognition, method = 'spearman')
corr4

corr4 <- cor.test(x= moira$`Deny uncertainty`, y=moira$Behaviour, method = 'spearman')
corr4

corr4 <- cor.test(x= moira$`Deny uncertainty`, y=moira$Cognition, method = 'spearman')
corr4

corr4 <- cor.test(x= moira$`Deny uncertainty`, y=moira$Metacognition, method = 'spearman')
corr4
```