

The Board Game Dixit as a Tool for The Development of Students' Physics Concepts

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Abstract

The paper presents experiences with the application of a modified version of the commercial board game Dixit as a physics educational tool. The game was tested by 9 pre-service teachers and 42 upper-secondary students. The goals of the presented research are to examine which physics concepts the students associate with selected Dixit cards and to examine if modified Dixit stimulates peer-discussion concerning physics concepts. Based on observation and post-game discussions, the modified version of Dixit can be used as an educational tool. Students showed positive attitude towards playing the game and they identified benefits of the game (finding physics in everyday situations, actively thinking about and using physics terms). However, the influence of the game on students' understanding of physics concepts, the suitability of various versions of the game for physics learning and the potential of the game to stimulate peer discussion requires further investigation.

Introduction

Children have been developing ideas concerning physics phenomena since their early years. By experiencing everyday life, practising physical activity, talking with other people or through consuming media, they build up ideas of how the world around them works. These ideas are often coherent with the children's domains of experience yet may differ substantially from the scientific view (Hadzigeorgiou, 2015). Even during formal education, children interpret presented experiments in diverse ways. According to Driver, Guesne & Tiberghien (1985, p.2):

“Individuals internalize their experience in a way which is at least partially their own; they construct their own meanings. These personal ideas influence the manner in which information is acquired.”

Existence of these ideas and their variety among students needs to be taken into consideration by teachers. It is important to identify these ideas and differences between them and the scientific view and to respond to them by planning activities that can support developing scientifically coherent physics concepts. One of the ways to develop physics concepts is to confront existing ideas with new experiences, to associate the ideas with new context or apply them within new situations. Peer discussion is another example of such method. According to Driver, Squires, Rushworth & Wood-Robinson (1994; p.5) peer-discussion “provides a forum in which previously implicit ideas can be made explicit and available for reflection and checking. It provides a situation in which individuals have to clarify their own notions in the process of discussion with others.”

In this research, the potential of board games as a tool for developing understanding of physics concepts was examined.

The potential of using games as an educational tool is a subject of Game-Based Learning research. Game-Based Learning is an educational approach which uses games (including board games) as an educational tool. Games are one of the most natural ways of learning. Specifically, board games have been part of human culture since antiquity (de Voogt, Dunn-Vaturi &

Eerkens, 2013). Recently, the popularity of board games has been rising (Bayeck, R. Y., 2020; p.412). Even, in the digital age, board games remain popular among people all over the world. Thanks to the wide variety of game themes and game mechanics, everyone can find a game that suits their interests and needs. Board games offer social interaction, entertainment, engagement, competitiveness, challenge players on different levels, and develop skills, such as problem-solving skills, communication skills, analytical thinking etc. Furthermore, board games have the potential to enable cognitive and behavioural development (Bayeck, R. Y., 2020). Applying board games in a learning process can direct this potential towards certain learning goals and take advantage of the many benefits of board games. Many studies point out the positive effects of educational games such as: players develop communication and teamwork skills (Dziob, 2020; Azizan, Mellon, Ramli & Yusup, 2018), players evolve in terms of self-evaluation and peer-evaluation (Seaborn & Fels, 2015), games can increase students' engagement in a subject (Cardinot & Fairfield, 2019).

While educational games research is growing globally, in Slovakia it is still in its early stages. Many Slovak schools use games for knowledge repetition and consolidation, but fewer focus on acquisition, cognitive development, and creativity. Research suggests that Slovak physics teachers lack knowledge and experience with physics educational games, and their use decreases as students get older (Horváthová & Haverlíková, 2012).

For the purpose of this research, the commercial board game Dixit was modified. Its potential as a tool for developing understanding of physics concepts was investigated.

The game - Dixit

Dixit is a board game published by Libellud Studios. It is a competitive game for 3 to 8 players, where every player plays for themselves. It consists of big cards with full-coloured illustrations (fig 1), scoring track and coloured figures (rabbits).



Figure 1: Examples of Dixit cards

Game mechanics

At the beginning of the game, each player gets 6 cards, which should not be seen by others. In every turn, one of the players becomes storyteller and several steps need to be done:

- The storyteller looks on their cards and selects one that inspires them. They need to come up with a clue for this card. Then, they place the card downwards on the table (without revealing it) and say the clue out loud.
- Each other player looks at their cards, finds one that seems to be associated with the clue and places it face-down on the table.
- The storyteller collects all the face-down cards on the table, shuffles them, then randomly places them on the table face-up.

- Other players guess which card belongs to the storyteller and was originally referenced by the clue. Then, each player votes for the chosen card. They cannot vote for their own cards.
- The storyteller reveals which card is theirs and the scoring phase starts.
- Players move their figures on the scoring track based on scored points.
- Cards used in this turn are placed away. Each player gets one new card and the player to the left of the storyteller becomes the new storyteller for the next turn.

In the scoring phase, three different situations can occur:

- If all players voted for storyteller's card or no players voted for storyteller's card, the storyteller does not score points, but the others score 2 points each.
- If some players voted for storyteller's card and some did not, the storyteller scores 3 points and each player who voted for storyteller's card scores 3 points.
- Each player (except the storyteller) scores 1 point if another player voted for their card.

This means that the storyteller needs to choose their clue wisely. The clue should not be too obvious or too difficult. Also, other players can confuse each other by precise choice of the card associated with the clue (Roubira, 2021).

Cards

The game consists of a pack of 84 80x120mm cards with unique illustrations. Cards picture dreamlike worlds and situations. There is no text on them. Illustrations have multiple meanings at different levels, which allows players to use their imagination to interpret cards differently. Another 9 extension packs of cards are published. Each pack was created by a different artist and consists of 84 cards which can be used to play Dixit.

Modification of the game

In our research, the commercial board game Dixit was modified and used as an educational game in physics lessons. The goal of the modification is to use Dixit as a tool to identify students' ideas concerning physics phenomena and to facilitate student discussion about physics terms, to verbalize students' ideas and physics concepts, and to confront their ideas with ideas of other students.

The game mechanics were modified in a way that players need to use clues within a physics context (physics phenomena, physics terms, equations, ...). Also, a new set of cards was selected from the basic set and all extension packs. Two researchers examined all the cards to write the physics associations to a given card within 15 seconds. The selection criteria were as follows: firstly, the card was associated with physics terms by both researchers; secondly, there were at least three different terms associated with the card. After first selection, the new pack consisted of 118 cards.

Research goal and methods

Goals

Goals of the presented research are:

- to examine which physics concepts the students associate with selected Dixit cards,
- to examine if the modified Dixit stimulates peer-discussion concerning physics concepts.

To achieve the goal, several research steps were followed:

1. Find out what physics concepts students associate with selected Dixit cards.
2. Testing of the game by pre-service physics teachers.
3. Testing of the game by upper-secondary students.

The research is part of broader research focused on the application of game-based learning in physics education, in which the potential of using selected games to bring benefits to students' knowledge and skills will be examined.

The first step

The first step was to find out what physics concepts are associated with the selected cards by graduates of general upper secondary education. To achieve this, 48 first-year university students of non-physics fields were randomly shown 10 of the 118 cards and asked to write as many physics terms as possible for each of the assigned pictures. 33 students voluntarily responded. The research was conducted online. Subsequently, quantity, diversity and relevance of terms associated to the cards was examined. To facilitate collection and analysis of data, all the cards were uniquely numbered.

The second step

In the second step, the modified Dixit was tested by 9 pre-service physics teachers during a lesson of the optional subject 'Educational Games'. Dixit was played in two groups consisting of 4 and 5 players. During the game, researchers recorded the storyteller's name, clue and the cards associated to the clue (example of a record in table 1). Card numbers refer to the specific cards that players associated to the clue. The subscript index refers to the number of votes for the individual card. The number of the storyteller's card is in bold. After the game, a discussion was held in the class about the game rules, selected cards and the potential of the game as a tool for developing students' physics concepts. The discussion was audio recorded.

Table 1: Example of record in report sheet

| Storyteller | Clue | Cards |
|-------------|------|--|
| Ema | Heat | 117 ₁ 80 ₁ 110 ₁ 29₀ 115 ₁ |

The third step

In the third step, the game was played by 42 upper secondary students during physics lessons. Students were divided in 8 groups consisting of 4 to 6 players. As there was only one researcher present during the game and 2 or 3 groups play simultaneously, the same report sheet as in second step was filled by players. Discussion concerning students' attitudes to the game, feedback of the game and benefits of the game for students took place after the game.


Research findings

The first step

Out of 118 cards, 111 cards were reviewed by students. From 0 to 37 physics concepts were associated to single cards, 2 cards were not associated with any concept despite the fact that they were reviewed. Time dedicated to reviewing the cards by students varied from 8 minutes to 3 days. The majority of associated concepts were connected to physics phenomena (reflection of light, sound, electricity, gravity, ...), physics quantities (pressure, force, mass, temperature, ...) or physics laws (Archimedes' law, energy conservation law, Newton's laws, ...). Fields of physics or names of scientists were used less frequently. Most of the students responded with concepts obviously connected to the cards, some of them provided concepts

with deeper, not so obvious connections. In Table 2, an example of a card with associated concepts can be seen.

Table 2: Card 56 with associated concepts

| Card | Associated concepts |
|---|---|
|  | <p>Respondent 1: Work, Resistance, Power, Time, Gravity, Mass, Force, Light Source, Luminosity, Radiation</p> |
| | <p>Respondent 2: Light, Motion, Speed, Mass, Air Flow, Gravity, Height, Stability, Center of Gravity, Reflection of Light, Angle, Pressure, Force, Length, Kinetics, Friction Force, Heat,</p> |
| | <p>Respondent 3: Comet, Height, Night, Stars, Wind</p> |

Subsequently, no cards were removed from the pack. Even 2 cards with no concepts associated to them by students were evaluated by researchers as cards with clear connections to physics concepts and they remained in the pack. Based on quantity, diversity and the relevance of concepts associated with cards, the pack of cards was considered suitable for further testing in the second and the third step.

The second step

Two game groups played several rounds of Dixit. Figure 2 shows a set of cards selected by players in one round of Dixit. The clue for this round was ‘lever’.








Figure 2: Cards associated with a clue lever

As can be seen, except for middle card, all cards can be associated with the clue. In the first card, it is a hammer, in the second card, it is a stick with a bag on the shoulder of a person, in the fourth card, the stilts are levers and in the fifth, the knife acts as a lever. The fourth card belonged to the storyteller. Only one player made the right guess, 3 players voted for the second card. The record of this round can be seen in Table 3.

Table 3: Record in report sheet – pre-service teachers

| Storyteller | Clue | Cards |
|-------------|-------|--|
| Livia | Lever | 97 ₀ 82 ₃ 76 ₀ 561 21 ₀ |

Table 4: Examples of the cards and associated clues – pre-service teachers

| Lumen | Faraday | Shadow | Density | Diffraction of light |
|---|---|---|--|---|
|  |  |  |  |  |

After the game, players discussed their observations. They struggled with the exactness of physics terms and concepts. In the original version of Dixit, clues are often made using word similarities, word associations or multiple meanings of words. In this version, players feel bounded by the exactness of physics. In the game, this resulted in one group having many rounds with a clear result (all players voted for storyteller's card). In the other group, there were several rounds where 2 cards had an obvious connection to the clue and the others did not. These situations brought frustration to some players because they were not able to decide which was the storyteller's card, as they both had an equal connection to the clue.

As future teachers, players discussed the potential of the game as a learning tool and what factors could influence the successful application of this game in a learning process. The following paragraphs contains selected statements from the discussion.

P1: *The game is suitable for students that are evidently interested in physics. In a general class, students not interested in physics would not enjoy the game, struggle with physics and get frustrated.*

P2: *Reducing and further selection of cards could manage to make the game more playable and enjoyable also for students not interested in physics. If physics associations on the cards are more obvious, the difficulty of the game will decrease...The composition of the groups is important. If the group is a mixture of students interested in physics and students not interested in physics, then it can be difficult to find the clues suitable for both which can result in frustration.*

P3: *On the other hand, it can be an opportunity for peer-learning in both directions. Students not interested in physics can be pulled to a higher level and students interested in physics need to think about the clues that will be suitable for the whole group, which can help them to develop their understanding.*

P4: *What is great about the game is that it shows physics in various unusual situations or environments. Even in the situations where you would never look for it and yet there is. And this can be motivating for students, something extra. It (physics) is not only in the books, but also something that I can experience.*

P5: *I cannot see the additional value of playing this game. We can project one of the cards on the wall and the task could be to find out as many physics' concepts associated with the card as we can. I do not know how the game help with it.*

P2: *I can imagine the game as a revision tool. For example, after completing optics, we can play the game with selection of cards focused on optics.*

P4: *Which limits the topics, and every player is on the same level.*

P5: *But then the form of the game is not necessary.*

P2: *The game gives it a sparkle, something motivating. But it is interesting what you said before. It can be interesting to practice with students in the way that after completing a topic, they get a card and need to find as many physics associations as they could. And at the end of the year, we can play the game.*

P6: *P5 also stated that for the teacher it can be beneficial to identify what associations, what terms or phenomena students noticed. Sometimes it can be the first plan, but it can be also not so obvious. It can be beneficial for both, for student by reminding the concepts, clearing their meanings and actively using them, and for teacher, by identifying students' physics concepts.*

The third step

Within a 45-minute lesson, the rules of the game were explained, groups were able to complete 5 to 10 rounds of Dixit and a discussion took place at the end of the lesson. A brief pre-game survey showed that majority of players knew the original game, which made explanation of the game easier. Eight groups played a total of 59 rounds of Dixit. Figure 3 shows the cards selected by players in one round of Dixit. The clue for this round was 'photons'.



Figure 3: Cards associated with a clue photons






'Photons' is a vague clue that can be associated with many cards. There is a high probability that other players within the group have a card associated with this clue. The storyteller's card is the fourth. Shining hands falling through the sky were associated with photons as light particles. Three players voted for this card, while the fifth and sixth card received 1 vote each. Table 5 contains the record of this round.

Table 5: Record in report sheet – upper-secondary students

| Storyteller | Clue | Cards |
|-------------|---------|--|
| Simon | Photons | 110 91 50 56 ₃ 43 ₁ 16 ₁ |

Based on observation of the game, upper-secondary students struggled less with the conflict of exactness vs. creativity. They used clues more creatively (few examples are presented in table 6). Clues connected to recently taught topics (friction, force, motions) or to commonly known physics concepts (light, gravity) were mostly used. In contrast with pre-service teachers, only a few rounds (15 of 59) ended with a clear result.

Table 6: Examples of the cards and associated clues – upper-secondary students

| Positive and negative charge | Physics exam | Attraction | Buoyancy | Friction |
|---|---|---|--|---|
|  |  |  |  |  |

The observed need for discussion about the clues and cards during the game was lower than expected. In the post-game discussion, some teams reported that after each round they explained to each other their thoughts about the cards and clue. But the majority of groups reported that they hardly discussed this during the game except in situations where certain clues or associations were not obvious. In general, students responded with positive emotions, enjoyment and engagement of the game and showed interest in playing the game again. This may be explained by the novelty effect, as students rarely have the opportunity to engage in game-based learning.

Concerning the benefits of the game, student A said: *“The game offers a different perspective on physics. We need to find physics concepts in real world.”*

Student B reacted: *“But these cards are not real!”*

And student A responded: *“Yes, but some parts of them are real. And in some way, they reflect real situations. We need to think about physics, about terms and phenomena connected to the cards to be successful in this game.”*

Interpretation

Testing of the modified version of Dixit showed that the game can be used as an educational tool. Interpretation of research findings is focused on cards, improvements of the game and peer-discussion.

Cards

Cards seems to be the most important part of the game. During the process of modification of the game, there was a question if the original Dixit cards would be suitable for the modified version of Dixit. The advantage of using the original cards is that the illustrations have several different meanings on multiple levels and therefore can be interpreted in many ways. Designing new specific cards for the modified Dixit requires significant additional work and there is a risk that the new cards will miss this advantage by being too specific or obvious. All 3 steps of the research showed that original Dixit cards can be used in the modified version, but the selection of the cards needs to be done more precisely and requires further research. Data collected in the second and third step suggest that some cards of our pack are more often used by players and are associated with more physics terms than others. To investigate this, the storyteller’s cards and the cards with votes from other players were sorted according to their original packs. Table 7 contains total number of cards in the modified pack sorted by their

original packs and how many of these cards were associated to the clue by storytellers or by votes of players.

Table 7: Number of cards in modified pack sorted by their original pack

| | Basic Dixit | Odyssey | Quest | Journey | Origins | Daydreams | Memories | Revelations | Harmonies | Anniversary |
|----------------------------------|-------------|---------|-------|---------|---------|-----------|----------|-------------|-----------|-------------|
| Number of cards in modified pack | 40 | 17 | 13 | 6 | 5 | 5 | 5 | 6 | 6 | 15 |
| Number of associated cards | 21 | 14 | 11 | 1 | 1 | 2 | 3 | 3 | 3 | 4 |

The cards most likely referred by the clue belong to Basic Dixit pack (52,5 %), Memories expansion pack (60 %), Odyssey pack (82,3 %) and Quest expansion pack (84,6 %). Cards from basic Dixit pack and Quest and Odyssey packs are illustrated by the same author, Marie Cardouat. They are illustrated in a similar style - simple, not overcrowded, colourful illustrations of dreamlike objects in real situations or real objects in dreamlike situations (fifth card in Table 6, first card in Figure 1). It seems that illustrations of this author can be more suitable for the modified version of Dixit, but it requires further investigation.

Other ways of using Dixit cards in physics education

Post-game discussions brought interesting ideas concerning other ways of using Dixit cards in physics education. Cards can be applied in the learning process in various ways:

1. *Just pictures.* Projecting pictures of the cards on the wall with the task for the whole class, to find out as many physics' concepts associated with the picture as they can.
2. *Pre-prepared set of cards for the round.* In this variation, players do not have any cards in their hands. A pre-prepared set of 5 or 6 cards is distributed upwards on the table. The storyteller reveals the clue associated with one of the cards. Players try to find out which card is referred by the clue. This variation decreases the randomness of the game. The teacher can intentionally choose sets of cards for each round to fulfill certain learning goals.
3. *A pack of cards selected for a certain topic.* This variation differs from the tested version by limiting clues by certain physics topic. The selection of cards in the pack takes into consideration this limit.

These variations can be applied independently or as a series of escalating activities with the goal of increasing students' sensitivity to this type of task. Any of these variations are not tested yet and require further research.

Peer-discussion

Based on the presented research it seems that modified Dixit in its current form is not a sufficient tool for stimulating peer-discussion. One of the reasons is that the game is not cooperative, and discussion is not required to successfully complete the game. Occurrence of peer-discussion seems to be strongly influenced by the composition of game groups and will be the subject of further research.

Conclusion and further research questions

Our research showed that the modified version of Dixit can be used as an educational tool. The usage of Dixit cards facilitates students' ability to identify instances of physics in contexts that are not typically perceived as such. The mechanics of the Dixit game may assist students in establishing connections between disparate physics concepts. We assume that the game has the potential to develop students' skills of analysis and evaluation of physics concepts and creativity. Students showed a positive attitude towards playing the game and they highlighted the benefits of the game (finding physics in everyday situations, actively thinking about and using physics terms).

The declared benefits of the game as an educational tool cannot be generalised, as the presented research was conducted only on the small research group and development of students' physics conceptual apparatus was not examined. Therefore, in future research several questions need to be examined:

1. What aspects of illustration make the cards more suitable for using in physics education?
2. Are presented variations of Dixit suitable for application in a learning process?
3. What is the impact of playing the modified Dixit on students' understanding of physics concepts?
4. What are the factors influencing stimulation of peer-discussion during the playing of the modified Dixit?

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